A SYSTEM

OF

DENTAL SURGERY.

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PREFACE.

In the following pages an attempt has been made to produce within the limits of a manual a strictly practical work on dental surgery. In order to fulfil this object, it became necessary to enter upon the structure and development of the teeth and jaws in a limited degree only, and to leave untouched any historical account of the writings of those who have from time to time contributed to our knowledge in this branch of surgery. The diseases of the teeth, and of the parts subservient to them, together with the coincident maladies, have been treated of, so far as may be, in the natural order of their occurrence, and the structure and development of the tissues involved have been to some extent described before entering upon the diseases to which they are respectively liable.

In a work devoted to the description of practical details, the modes of proceeding in the treatment of diseases, whether by operations or otherwise, must necessarily be those practised by the author. The methods adopted by others are known only through published descriptions, the mere reprint of which would be but a work of supererogation. On this account, together with the want of space, the quotations from other writers have been but limited. I must, however,

express my obligation to many of those who have written upon dental surgery, and I cannot leave unmentioned the names of Mr. Bell, Mr. Spence Bate, Mr. Samuel Cartwright, Mr. Chapin Harris, and Mr. Arthur. Reference is not unfrequently made to a series of lectures published in 1848. Many subjects but imperfectly touched upon in these pages are more fully treated in that work, and many specimens are there figured which illustrate subjects discussed in this volume.

The demands of an active practice leave but little leisure for writing, and that little has been seriously interrupted by engagements consequent upon the gradual organization which the dental profession has recently undergone. From these, and from causes less controllable, the present work has passed very slowly through the press, many of the earlier sheets having been in print upwards of eighteen months.

To Mr. Bagg I am greatly indebted for the highly artistic illustrations which he has produced from specimens in my own collection, and from others which have been liberally contributed by my professional friends.

37, Cavendish-square,
London, February 28, 1859.

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ERRATUM.

Page 299, *for* Rainie *read* Rainey.

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TEETHING.

The term *teething* might be employed to express the development of the teeth from the commencement to the completion of the formative action; but custom has limited its use to the expression of a single phase of the process—that is, to the eruption or cutting of the temporary teeth. Although this, nearly the last in a series of developmental actions, may be regarded in many respects as the most interesting, and the one which the medical practitioner is usually required to watch, yet if observation were restricted to the eruption of the teeth without instituting an inquiry into the preceding conditions, our knowledge of the subject would be very imperfect. It is proposed, therefore, in the present instance, to describe the conditions of the teeth and jaws at the time of birth, and to trace the changes onwards until the temporary teeth have arrived at maturity.

At the time I undertook to write the present volume, the museums in which an extended series of young skulls would be likely to be found were visited, but without success. So far as I could learn, no such series existed. It therefore

became necessary to make a collection, taking care that the age of each specimen should, if possible, be ascertained. This has been done, and the preparations comprised in the collection are sufficiently numerous to allow of deductions being made from the characters they present. But should the conclusions drawn from the study of these ultimately prove, in some respects, incorrect, the want of accuracy can be substantiated by the study of a still more extended series only. But until such a collection is made, it will be safer to adopt the conditions of the preparations at present at my disposal, as fair examples of the states of the dental apparatus at the several ages, than to assume that the opinions generally extant, when at variance with them, are in all cases correct. Feeling that this course is the more likely one to lead to a correct knowledge of the subject, I shall, in the following pages, describe the conditions presented by individual specimens, selecting such as appear most typical of the ages chosen for description.

If two perfectly healthy children, whose ages are similar, be selected for examination, we shall rarely find that they present precisely similar conditions as regards the rate of teething; yet there will probably be no great disparity in the conditions of the two. Each will pass through the same phases, although, until the process of dentition is completed, one may be a few weeks, or even months, in advance of the other.

There is, however, another source of fallacy to be guarded against. The specimens obtained are necessarily taken from individuals who have been the subjects of disease; and supposing the fatal illness to have been of long standing, the jaws may have been modified. That such has occurred to some members of the series is sufficiently obvious, but the diseased

action appears to have influenced the growth of the jaws themselves, rather than the rate of development of the teeth. Hence, even these specimens may serve to confirm the results obtained from an examination of healthy jaws so far as the teeth are concerned.

Those minor differences in size and form which constitute individuality, and by which we are enabled to distinguish one individual from another, in all the essential characters precisely similar, must be borne in mind when investigations of this character are undertaken.

It would perhaps be difficult to find a more interesting subject for investigation, than the progressive changes in form and of relative proportions between the various parts of the jaws during infancy; occurring as necessary consequences of their mode of growth, and connected as these changes are with the development and arrangement of the teeth.

The fact that the development of the hard tissues of a tooth is preceded by the formation of soft tissues, or tooth-pulp, of equal size and form to the future tooth, must at all times be kept in view. Not that the pulp assumes the dimensions of a perfected tooth before the development of the hard tissues commences, but that each part of the gradually developing tooth is first formed in soft tissue, which then calcifies. For example, the cusps of the molars and the edges of the front teeth first assume the full dimensions in the form of pulp, and then calcify; the process of gradual development and subsequent calcification proceeding until the teeth are perfected. In dentine, which forms the great bulk of each tooth, we have no such thing as outward growth; no addition to the external surface of the formed tissue ever takes place, except-

ing by the superposition of the enamel, and cementum, which respectively coat the crown and the root of the tooth; but these add comparatively little to the size of the organ. Hence it follows that both the forms and dimensions of the crowns of the teeth are unalterably fixed long before the jaws are sufficiently enlarged to admit of their ultimate and normal arrangement.

If the maxillæ of a *full-grown fœtus* be examined, it will be found that the union of the two halves both of the upper and lower jaws is effected by the interposition of fibro-cartilage, which allows a certain amount of motion between the parts thus connected. The alveolar margins are deeply indented with large open crypts, more or less perfectly formed. The depth of these bony cells is sufficient only to contain the developing teeth and teeth-pulps, the former rising to the level of the alveolar margins of the jaws. At this period the crypts or alveoli are not arranged in a perfectly uniform line, neither are they all equally complete. The septa, which divide into a series of cells that which at an earlier age was but a continuous groove, are less perfect at the back than at the front part of the mouth. The alveoli of the central incisors both of the upper and lower jaws are a little larger within than at the orifice, and this difference is made still greater by a depression upon the lingual wall of each for the reception of the pulp of the corresponding permanent tooth. They are divided from the crypts of the lateral incisors by a septum, which runs obliquely backwards, and a little inwards towards the median line. The sockets of the lateral incisors occupy a position slightly posterior to those for the central teeth, and are divided from the canine alveoli by a septum which proceeds obliquely backwards, and in the lower jaw (as regards the median line of

the mouth) outwards (Fig. 2). By the arrangement of these divisions, the alveoli of the central incisors are rendered broader in front than behind, and the relative dimensions of the sockets of the lateral teeth are reversed, as shown in Figures 1 and 2. The crypts of the canine teeth are placed a little anterior to those of the laterals, and nearly in a line with the central incisor sockets, giving to the jaws a somewhat flattened anterior surface. The septum dividing the canine from the first temporary molar crypt is not subject to the obliquity observed in the two preceding examples, but proceeds directly across from the outer to the inner alveolar margin, giving to the socket for the canine a greater breadth in front than behind, which peculiarity is still further increased by the anterior wall being bulged outwards. In these alveoli we have at present no depression provided for the pulps of the permanent teeth.

The sockets for the first temporary molars are placed in the median line of the alveolar ridge; have a somewhat square form, with the outer margins inverted; and in the lower maxilla they are marked on their floors by a slight groove, in which the inferior dental nerve and artery lie. These enter the alveolus on either side through an aperture in the base of the septum, which divides imperfectly the first from the second temporary molar, and pass out to the external surface of the jaw through an orifice in the septum separating the canine from the former tooth.

Posterior to the alveoli for the first temporary molars we have a large open socket, which, in the upper maxilla, has but a very imperfect posterior wall. Projecting inwards from the free edge of the outer and inner alveolar walls, we may observe small spicula, the rudiments of a septum which is destined to divide the cavity into two distinct sockets, and

thus separate the pulps of the second temporary and first permanent molar teeth, both of which at present occupy one large alveolus. The division usually takes place a little earlier in the lower than the upper jaw. The groove which marks the passage of the nerve and artery in the floor of the socket of the first temporary molar, is continued through the alveoli of the two posterior teeth, having entered by the inferior dental foramen, situated midway between the angle of the jaw and the edge of the inner wall of the alveolus of the first permanent molar, a little below the floor of the posterior part of the last alveolus.

At this period the articular process of the lower jaw is scarcely raised above the level of the alveolar edge, while the angle is projected downwards a little below the general level of the inferior margin of the jaw. The coronoid process rises at an angle of forty-five degrees from the alveolar edge, its ascent commencing at the anterior boundary of the socket of the first permanent molar. In the upper jaw the zygomatic process proceeds outwards from the anterior margin of the large open socket of the second temporary molar.

It is necessary to notice, with some degree of accuracy, the relative position of these points, as in tracing the growth of the jaws, changes occur which can be recognised only by a knowledge of the preceding conditions.

The inferior border of the lower jaw in the nine-months' fœtus is undulated; the angle and the point where the sockets of the first and second temporary molars join being the lowest points, while the intermediate parts of the margin are curved upwards. Viewed in profile, it will be seen that the alveolar margin projects over, and therefore forms a bolder curve than

Fig. 1. (1)

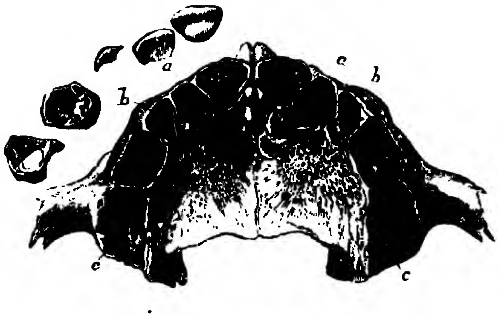
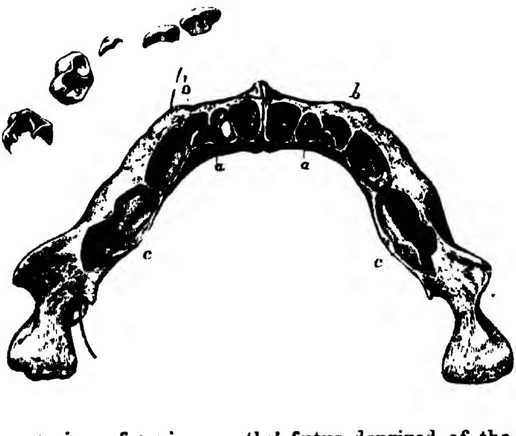


Fig. 2. (2)



(1) The upper jaw of a nine-months' fœtus deprived of the soft parts, showing the relative positions and dimensions of the alveoli, the partly developed teeth having been removed from the sockets on the right side of the jaw. *a*, the socket of the lateral incisor; *b*, that of the canine; *c*, the alveolus of the second temporary molar, the posterior wall at this age being absent. This and the subsequent figures are two-thirds life-size.

(2) The lower jaw of a nine-months' fœtus, showing the condition of the alveoli. *a*, the sockets of the lateral incisors; *b*, those of the canine teeth; *c*, the alveoli of the second temporary and first permanent molars. A bristle is placed in the inferior dental canal.

the inferior border of the jaw. At the junction of the two halves each portion is expanded, forming on the anterior surface a vertical process, which extends from the alveolar to the inferior margin of the maxilla, the greatest prominence being attained in the middle part of its course. (Fig. 4.)

Fig. 3. (1)

Fig. 4. (2)

The position of the zygomatic process has been already noticed, but the general characters of the alveoli remain to be described. In the upper jaw the inner alveolar ridge descends but little below the level of the hard palate, although the

(1) The upper jaw of a nine-months' fœtus, the soft parts having been removed, showing the outer surface of the alveolar processes. *a*, the depressed portion corresponding to the position of the lateral incisor.

(2) The lower jaw of a nine-months' fœtus, showing the relative size and position of the several parts of the bone at this age.

sockets have attained a considerable depth. At this age the antrum is represented by a depression on the outer wall of the nasal cavity, while the alveolar cavities extend to the base of the orbit, from which they are separated by a thin plate of bone; similar relations being maintained with regard to the anterior part of the nasal cavity.

The temporary teeth at this period are partly formed. The central incisors are calcified through the greater length of the crown; but the lateral teeth are less advanced. The terminal points only of the canines are calcified, while the masticating surfaces of the first temporary molars are completed, excepting the enamel, which at this stage has not attained more than half its thickness, a condition common also to the more anterior teeth. The second temporary molar is represented by calcified cusps, which are united in a circle, the central part of the crown being as yet uncalcified. The conditions are shown in Figs. 1 and 2. If examined in the recent state, it will be seen that in the front teeth calcification has advanced nearly to the base of the tooth pulp, which ends in a broad flat surface; while in the canines and molars the pulp extends a short distance below the terminal line of calcification.

By dividing the mucous membrane and subjacent periosteum a little below the upper margin of the alveoli, both on the labial and lingual surfaces of the jaw, in a specimen which has been kept a short time in spirit, and then carefully raising the membrane from the surface of the bone, we shall be enabled to withdraw from their sockets the developing teeth enclosed in their sacs, which will remain firmly attached to the gum. The relative position of the dental sacs will be

seen to correspond with the arrangement of the alveoli already described. The union of the external coat of the sac with the tissues of the gum, and of the lower portion of the pulp with the base of the sac, may be demonstrated.

At the age of *two months* but little change from the fœtal characters has taken place in the upper jaw. The maxilla is, however, generally a little larger, and the sockets slightly deeper and more prominent at the anterior free margins, than at the time of birth; the relative position of the teeth being unchanged. In the lower jaw the differences are much more strongly marked. In addition to a general increase of size, growth has advanced rapidly in the ramus, and the angle become less obtuse. The articular process rises above the general level of the alveolar ridge, an indication that during the early weeks of infancy growth is more active in the ascending ramus than in any other part of the lower jaw. At the point of junction of the two halves, increase in the depth of the jaw may be observed. This has been in great part effected by additions to the free edge of the alveoli, which have been extended anteriorly into a somewhat larger curve. But in addition to growth in the positions mentioned, development has gone on from the opposed surfaces of the two halves encroaching upon the fibro-cellular tissue which connects them. The structural character of this development will be subsequently considered. Similar changes occur in the suture connecting the two halves of the upper jaw. Growth proceeds in the line of junction of the two halves, and indeed at each of those points where the bone is at present connected only by soft tissue to the adjoining bones. Increase of bone in the median line would necessarily lead to separation of the

central incisors; this is, however, prevented by the teeth on either side inclining towards the centre, and the sockets partake in a similar change of direction, the free edges of

Fig. 5. (1)

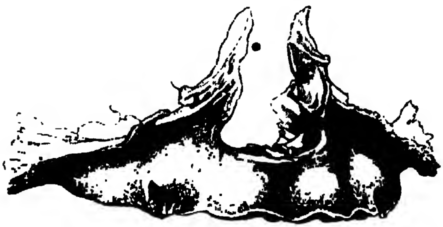


Fig. 6. (2)

which are closely approximated, while the deeper parts become separated from each other.

At the age of *two months*, the teeth are more advanced in development than at the time of birth, but the change is not

(1) The upper jaw of a male two months old, showing the general increase of size as compared with the fœtal jaw, and the increased depth of the alveolar processes.

(2) The lower jaw of a male two months old, showing the increased size as compared with the fœtal jaw given in Fig. 4, and the changes in the relative position of the body and ascending ramus during the two months succeeding birth.

so strongly marked in them as in the maxillæ. The crypt of the pulp of the first permanent molar is yet without a posterior wall in the upper jaw; and in the lower jaw, the

Fig. 7. (1)

Fig. 8. (2)

(1) The upper jaw of a male two months old, showing the condition of the alveoli and forming teeth at that age.

(2) The lower jaw of a male two months old, showing the condition of the alveoli and teeth at that period.

septum dividing this from the socket of the second temporary molar is incomplete.

When the *third month* has been attained, the maxillæ show a further development in the directions already indicated. The angle of the lower jaw is more pronounced, and the bone much more solid. The alveoli, however, exhibit a considerable change in character; their depth has increased; and the free edges, which were before open, so that in a macerated preparation the teeth readily fall out, are now turned inwards

Fig. 9. (1)

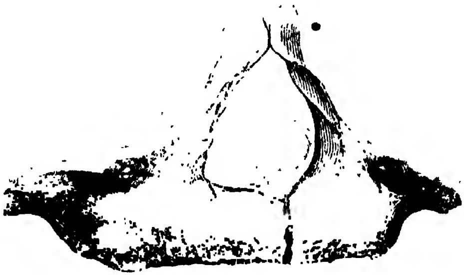


Fig. 10. (2)

(1) The upper jaw of a male three months old, two-thirds life-size.

(2) The lower jaw of a male three months old. In the specimen from which this figure is taken the lateral incisors are wanting.

towards the median line of the alveolar ridge, thereby contracting the orifices, and affording protection to the enclosed

Fig. 11. (1)

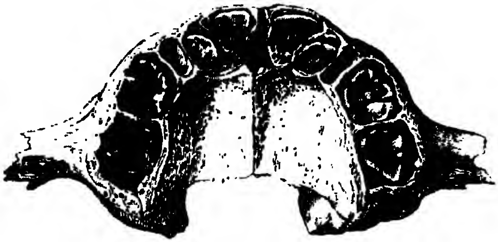
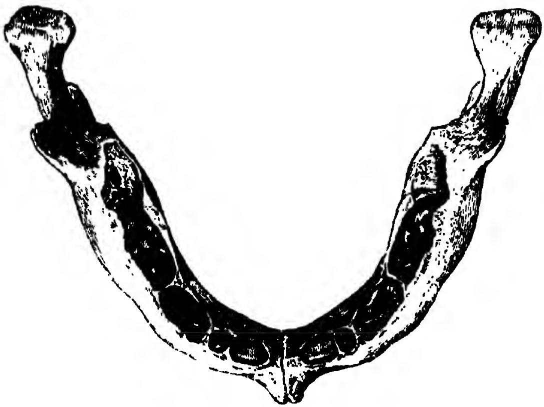


Fig. 12. (2)



(1) The upper jaw of a male three months old, showing the advanced condition of the alveoli, and the inversion of the edges of each socket, together with completion of the posterior wall of the sockets which contain the second temporary molar and the pulp of the first permanent molar.

(2) The lower jaw of a male three months old, showing the inversion of alveolar edges, and consequent contraction of the apertures. The lateral incisors are wanting.

teeth, which are no longer liable to fall out when the bone is examined. The direction of the rami is but little changed, but considerable addition of bone at the lower border of the angle will be observed, the sigmoid notch at the same time being widened. The symphysis is still strongly marked in each half of the bone, and viewed in profile the curved outline is still preserved. The figures illustrating the condition peculiar to this age are singular from the absence of lateral incisors in the lower jaw, and in the want of a crypt for the first permanent molar on one side of the upper jaw. In other respects they present the characters common to jaws of similar age.

Passing from a subject of three to one of *six months old*, the differences are not at first sight very striking. The angle formed by the borders of the body and ramus of the lower jaw does not appear to be less obtuse than in younger skulls. This is, however, due to a considerable increase of bone on the lower border, especially near and about the symphysis, at the same time that the mental prominence is beginning to appear and occupy a more forward position than the outer margin of the alveolar ridge. The sockets are generally increased in depth, but in a greater degree in the anterior than at the posterior part of the line. The posterior wall of the crypt of the first permanent molar in the upper maxilla is still imperfect; and the septum between the second temporary and first permanent molars in the lower jaw is incomplete. The teeth at the age of six months are more advanced than at the ages previously described; but the difference is much more marked in the incisors than in the other teeth. The canines and second molars are more forward,

but the rate of progress has been slower than in the other teeth.

The inversion of the edges of the alveoli, and consequent narrowing of the apertures described as pertaining to the jaws of three months old, is less pronounced at six months, although as yet the teeth lie below the free edges of the sockets. The increased size of the alveolar orifices must be regarded as the first of those changes which precede the eruption of the teeth.

The relative position of the teeth is but little changed; the canines of the upper jaw are even more out of the regular line than formerly, being placed at this period almost external to the lateral teeth, thereby producing great prominence in the jaw at these points.

The bony cells for the permanent central incisors are now well marked, producing a prominence on the palatine surface of the alveolar process, but they usually communicate with crypts of the temporary teeth by a large orifice. The cells for the permanent lateral incisors are at present indicated only by a depression on the lingual surface of the crypts occupied by the temporary teeth.

At the age of *eight months* we may see indications of further progress. In the specimen figured, that of a male nine months old, the conditions of the alveolar ridge are becoming rapidly changed. At the front part of the mouth, the alveoli, which have hitherto developed more rapidly than those situated further back, now become the seat of absorption; while the more posterior ones assume a greater activity of growth. The central incisors of the upper jaw, although they do not descend below the general level of the

alveolar ridge, are exposed on their anterior surfaces by the absorption of great part of the outer wall of the sockets, at the same time that the teeth have moved bodily a little forward. The outer edges of the central are in front of the lateral teeth, the latter being still placed in a line internal to the canines, so that if the teeth were cut in their present positions, the arrangement would be extremely irregular. Indications of the removal of the anterior walls of the sockets of the lateral incisors are shown in their emarginated edges, while the alveoli of the other teeth still preserve their inverted margins.

The crypts of the permanent central incisors are becoming separated from those of the temporary teeth by the growth of septa, which rise towards the surface from the deeper part of the sockets; and growth is continued in this direction until the opening becomes level, or nearly so, with the free margin of the sockets of the temporary tooth.

The sockets of the molar teeth, which in the fœtus extended to the floor of the orbit, are now separated from it by the antrum, which at this time is represented by a deep depression, extending under the orbit in its inner two-thirds. The septum between the socket of the second temporary and first permanent molar is still imperfect, and the posterior wall of the crypt of the latter tooth, although incomplete, is in progress of development.

In the lower jaw the changes from the earlier conditions are more striking. The two halves, which in the upper are still separable, are in the inferior maxilla becoming united, and no longer part under maceration. The symphysis and mental prominence are strongly marked, the bone behind the front teeth is thickened, and at the alveolar margin turned

outwards, giving a curved surface, the convexity being directed towards the tongue,—a form altogether different from that of the corresponding part in the mature fœtus, when

Fig. 13. ([1])

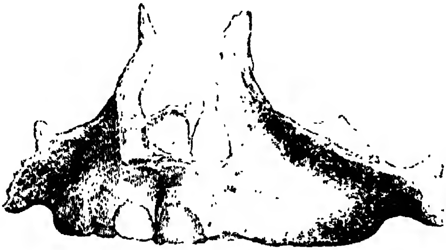


Fig. 14. ([2])

([1]) The upper jaw of a male nine months old, showing absorption of the anterior walls of the sockets of the central incisors preparatory to the escape of the crowns of the teeth from their alveoli.

([2]) The lower jaw of a male nine months old, showing absorption of the outer walls of the socket of the incisors preparatory to the eruption of those teeth. Two-thirds life-size.

the line of the symphysis at the posterior surface of the jaw is straight. It was shown that in the fœtal jaw the point of the inferior border corresponding to the position of the first and second temporary molars, descends to a lower level than the parts anterior or posterior to it. In the nine-months' jaw, the relative depths of the three parts indicated are changed, the middle portion now being the highest. The removal of the anterior wall of the alveoli of the central incisors, and partly also of that of the lateral teeth, has been effected in the lower as in the upper jaw.

Taking the jaw figured as a fair standard of the conditions peculiar to this age, it will be seen, on comparison with the preceding figures, that the bone has undergone great change, not only in size, but also in form, and that the changes in form are more remarkable in some parts of the jaw than in others. In instituting a comparison of the relative changes which mark the growth, it becomes necessary to adopt fixed points from which to make measurements, and several of these should be selected from those parts of the jaw which are the least subject to alterations of position. The foramen mentale is particularly suitable as a point from which to take relative dimensions, as its position may be practically assumed as fixed, undergoing little or no change after birth. In the full-grown fœtus it is situated at the point corresponding to the septum which divides the sockets of the temporary canine and first temporary molar, and on a plane with the bottom of the alveoli. In the adult jaw, the foramen is in close proximity with the extremity of the root of the first bicuspid—that is, on a level with the bottom of the socket of the tooth which succeeds the first temporary molar. Now, assuming that the

position of the latter tooth and its successor remains unchanged during growth, while other parts undergo alterations, we have a point from which the relative amount of increase of different parts, and of the same part at different ages, can be determined. The slight difference in the position of the mental foramen in the fœtal and in the adult jaw, is in great part, although not entirely, accounted for by the difference in the direction of the terminal portion of the inferior dental canal in the two subjects. In the fœtus it passes directly forwards and outwards, its orifice being directed forwards; whilst in the subject of nine months old and in the adult, the canal is turned upwards, and often a little backwards, at its terminal portion, and the orifice directed upwards and backwards, thereby giving a position somewhat posterior to that which would have obtained had the direction of the opening remained unchanged.

On the inner surface of the lower jaw the tubercles for the attachment of the *genio-hyo-glossus* and *genio-hyoideus* undergo but little change during the growth of the jaw. In the fœtus they are placed opposite to and a little below the base of the sockets of the central incisors: the two upper tubercles being, even at this early age, well marked. In the adult subject the position as regards the central incisors is the same, excepting in those cases in which the alveolar process is developed in an unusual degree. Then the extremities of the roots of those teeth occupy a higher level than the *spinæ mentales.* The upper of the two pairs of processes are at all ages nearly in the same level as the mental foramina, a slight advantage in height being commonly in favour of the latter.

If, on the inner surface of the jaw, the distance between the

junction of the septa between the sockets of the first and second temporary molars and the inner plate of the alveoli of either side be measured in the full-grown fœtus, and in jaws up to the age of nine months, when osseous union between the two halves usually commences, and the measurement be made on a level with the attachment of the genio-hyo-glossus muscle, it will be found, that although the jaws have with age greatly increased in size, yet the distance between these points has not materially increased. Again: if a line be stretched across from the above points, and measurements be made from the centre of the line to the upper of the two pairs of spinæ mentales, it will also be found that the distance has not increased with the ageing of the subject. But if the measurement be made from the centre of the line to the anterior alveolar plate, it will be seen that the distance between these two points gradually increases with the age of the subject, and that the front teeth contemporaneously assume a more forward position. The stationary condition of the inner, while the outer alveolar plate and teeth are moved forward, allows the former to increase in thickness, and afford receptacles for the pulps of the anterior permanent teeth.

An examination of the mental foramen through a similar range of subjects, will show that the slight change of position which this opening undergoes takes place within the first six or eight weeks after birth, and that having gained a point corresponding to the middle of the floor of the socket of the first temporary molar, no further change of position is produced.

The growth of the anterior part of the jaw by addition of bone previous to union at the symphysis, may be computed by relative measurements of the fœtal and nine-months' jaws. An

increase of distance between the symphysis and mental foramen, amounting to the eighth of an inch in favour of the older jaw, is shown. This increase will be found to correspond in amount with the greater thickness in the antero-posterior direction near the symphysis of the nine-months' jaw over that of the fœtal organ If a line be drawn the eighth of an inch in front of the symphysis of the fœtal jaw, and the distance from the mental foramen to that point of the line corresponding to the symphysis be taken, it will be found to agree with the measurement of the nine-months' jaw between the points already described. The foregoing facts show sufficiently clearly that the growth of the anterior parts of the lower jaw is produced by addition of bone to the anterior surface, rather than by any material increase by the development of bone in the fibro-cellular tissue which, up to this period, unites the two halves. Development in the latter position appears to have its period of activity limited to intra-uterine life. After birth, the process of growth in this direction is all but suspended until the period arrives for the osseous union of the two halves of jaw, when the action is resumed, the fibro-cellular tissue is replaced by bone, and all further increase at this point is then at an end. Still keeping the mental foramen as the point from which to make the computations of relative growth in different directions, it will be found, by examining the series of jaws, that additions have been made to the lower border of the jaws, but that there has been relatively a much greater activity shown in the alveoli, which at the age of nine months have acquired their maximum height in the front part of the jaw. The length of the jaw posterior to the mental foramen is steadily increased with the increasing age of the subject, the

direction of the growth being indicated by series of minute vascular grooves which mark the bone at and near the angle of the jaw. Between these grooves the bone rises into minute ridges, many of which are continued to the posterior border of the ramus, and there terminate in short slender spicula, giving to the border a rough surface, which, although well marked in many dry specimens, is much more strongly pronounced before the bone is allowed to dry, and the partly-calcified spicula to become contracted by the loss of moisture. If these grooves are traced through a series of specimens of progressive ages, commencing with the fœtal jaw, it will be seen that those about the coronoid process indicate the course in which that part has advanced; a line which, I shall subsequently be able to show, is permanently marked in the adult jaw by the external *oblique line.* Then again, a similar line of grooves indicates the course which has been taken by the articular process in its progressive growth upwards and backwards. Indeed, this line is also indicated by the surface being slightly raised. Below, and a little posterior to this line, we have the angle of the jaw, the increase in which has been already noted.

M. Kölliker has shown that the articular cartilage is of unusual thickness for cartilage so placed; and that, in addition to the usual functions of articular cartilage, it is here subservient to the purposes of development, its office in one respect being similar to the cartilage which in childhood is placed between the epiphysis and shaft of a long bone. It is not proposed to enter upon the subject of osseous development, until the changes of form and increase of size of the maxillæ have been traced from birth to manhood. But the discovery first re-

corded by M. Kölliker has been mentioned, in order to show that in whatever direction the jaw has increased, the increase has been produced by additions to the external surface. There are no indications of interstitial growth within and throughout the whole substance of the bone. It is not unusual to find increased size of a bone described as expansion, but the term is not applicable. We may have great increase in the size of the medullary cavity and of the circumference of a long bone, as seen in diseased limbs; but in such cases the enlargement of the cavity is produced by progressive absorption of its parietes, and the enlargement of the outer dimensions by development of bone upon the surface.

The description of the jaws of the nine-months' child has been given at greater length, in consequence of the specimen having attained that stage of development which immediately precedes the eruption of the teeth.

The conditions of the alveoli coincident with the progressive development of the teeth, do not appear to have attracted that amount of attention which the subject deserves; and the stage in which the wall or walls of the sockets are partially absorbed preparatory to the passage of the teeth through the gums, although an important and necessary action for the liberation of the crown of the tooth from the socket, seems, so far as I know, to have escaped observation altogether.

If the teeth of the specimen which has been under consideration be removed from their sockets and examined separately, it will be seen that the crowns of the central incisors are perfected so far as their exteriors are concerned, and that the production of the necks of the teeth has commenced. The enamel of these teeth presents the character which marks

the completion of its development—namely, the smooth and polished surface which succeeds to the dull, opaque, and almost chalk-like character maintained so long as the tissue is incomplete. The lateral incisors present similar appearances, excepting that the neck is less pronounced than in the central teeth. The canines at present are placed deep in the sockets, the crowns being incomplete, contrasting strongly with the teeth immediately behind them. These, the first temporary molars, have the crowns nearly completed, the masticatory surfaces of which are on a level with the alveolar margin. The latter parts have already been slightly reduced by absorption, and the outer apertures of the sockets have been thereby en larged. The second temporary and the first permanent molars, although considerably advanced as compared with those of the six-months' subject, are still considerably below the level of the alveolar margins, the outer of which is turned very much inwards, and hence the openings of the sockets are contracted, an arrangement calculated to afford protection to the developing teeth.

Passing from the nine to the *twelve-months'* subject, further changes in the dental apparatus will be observed, indicating that during the intervening three months the process of teething, as the term is commonly understood, has fairly set in, and at the latter age is in full activity. In the upper jaw the two halves of the bone are becoming united; and although they may be separated after maceration, yet it requires some force to part them, a condition very different to that which obtains at an earlier period, when they readily fall apart. It was stated that the anterior wall of the alveoli of the central incisors in the nine-months' jaw, had been diminished by ab-

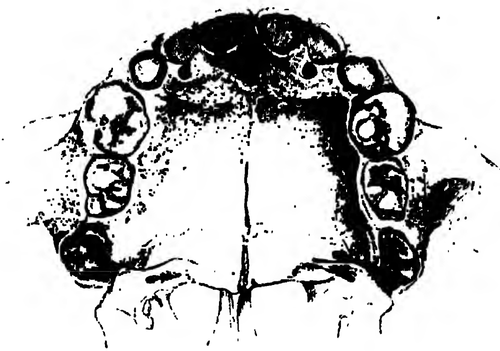
sorption, exposing to view the crowns of the teeth, although these organs did not rise above the general level of the alveolar ridge. At the age of twelve months the crowns of these teeth have escaped from the sockets to the extent of half their length, the whole of the enamel on the anterior surface being visible. They are placed against the anterior wall, and are separated by a considerable interval from the posterior wall of the alveoli. The latter process at this age descends below the level of the anterior wall of the sockets, at the same time that an increase of thickness of the bone at this part is allowed by the forward movement of the incisor teeth. The crypts of the permanent teeth become enlarged, occupying the space which has been gained. The apertures leading to the permanent incisors are now situated near the alveolar margin, but at present open upon the inclined surface which forms the posterior wall of the enlarged sockets of the temporary teeth.

The alveoli of the canines preserve their depth, but the opening is somewhat larger than heretofore, indicating the commencement of the change which precedes the eruption of those teeth. The lateral incisors have escaped from their alveoli to the extent of two-thirds of their crowns. The canine prominences on the anterior surface of the jaw, which during the earlier months of life form so strong a feature, are now becoming lost; not, however, by their own subsidence, but by the advancing forwards of the alveoli of the neighbouring teeth. The first temporary molars at this age have passed through the apertures of the sockets, and the emargination of the external plate is gradually becoming lost, the process of development having succeeded to that of absorption.

The alveolus of the first permanent molar, which at an earlier age was destitute of any posterior wall, and had a large open orifice, has now become more perfect, and communicates

Fig. 15. (1)

Fig. 16. (2)



(1) Upper jaw of a male thirteen months old, showing the incisors, with the crowns escaped from the alveoli, and the emargination of the socket of the first temporary molar.

(2) The palatal surface and the alveolar margins of the same specimen.

with the surface by a comparatively small opening situated on the alveolar ridge, and in a line with the openings of the anterior sockets. The lingual margin of the socket is much more

Fig. 17. (1)

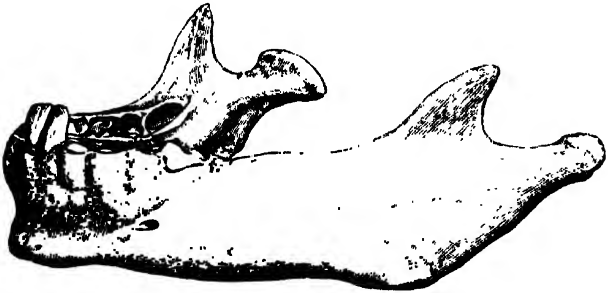
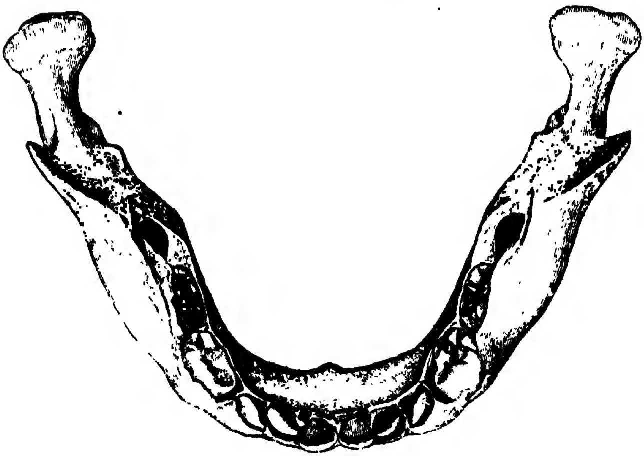


Fig. 18. (1)



(1) The condition of the lower jaw and teeth of a thirteen-months' male subject. In this example, the first temporary molars of the upper do not appear more advanced than the corresponding teeth of the lower jaw—a condition which is rather unusual.

strongly developed than that of the outer alveolar plate, and indeed rises into a process continuous with the corresponding part of the sockets of the more anterior teeth. The base is continued outwards so as to arch over the inner part of the developing tooth, a condition calculated to protect the latter from mechanical injury, now that the mouth is becoming furnished with organs of mastication.

Excepting in a general increase of size, the lower jaw does not present any considerable change in character from that of the nine-months' subject. The central incisors have risen out of the sockets, and the emargination of the outer plate of the alveoli of the lateral incisors and of the first temporary molars has commenced; those teeth are, however, scarcely raised above the level of the alveolar ridge.

The next specimen in the series is that of a female subject, *eighteen months* of age. This, as compared with the twelve-months' maxillæ, shows an advance in the process of dentition, but not to the extent usually assigned to the age. The crowns of the central incisors both of the upper and lower jaws, are fully exposed; but the fangs, although approaching the normal length, are as yet incomplete, the extremity of each presenting a sharp thin edge, with a large aperture, instead of the conical termination, perforated by a minute foramen, peculiar to perfected teeth. The lateral incisors have emerged from their sockets, but the crowns have not reached to the level of the central teeth, those of the upper being more forward than the corresponding teeth of the lower jaw. The conical points of the canines have become visible above the emarginated edges of their alveoli; while the first temporary molars have been protruded in the upper to the extent of two-

thirds of their crowns, and to one-third in the lower jaw. The roots exhibit corresponding stages of development, those of the upper jaws being nearly half their ultimate length, and the lower ones about one-third. The second temporary molar is at present wholly within the socket, the margins of which are arched over so as to diminish the alveolar aperture, and protect the developing tooth, an effect which is partly produced by the edge of the external alveolar plate being more produced in height, and at the same time more arched over the tooth than the inner edge of the socket. The roots of these teeth are scarcely indicated, excepting by the septum of dentine which in each may be seen extending across the base of the crown, and marking the position for the future roots. The first permanent molars lie deep within their respective sockets, the orifices of which in the lower jaw are contracted by the inversion of the outer alveolar plate and the base of the coronoid process, the teeth at this time being placed with their posterior two-thirds, internal to that portion of the jaw. The posterior edge of the socket is brought forward over the back part of the crown to the extent of one-fourth of its antero-posterior dimensions. On the upper surface of this, within a line of its edge, a depression in the bone may be seen. This is the commencement of a crypt for the second permanent molar. (Fig. 18.) The corresponding teeth of the superior maxillæ occupy the tuberosity, the posterior part of which is extremely thin, and in the median line imperfect. This gives a long and curved opening to the socket, and a posterior direction to its further half. In the upper jaw we have as yet no indications in the bone, of preparations for the lodgment of the second permanent molar.

If the eighteen-months' maxillæ are compared with those of twelve or thirteen months, the relations of growth between the teeth and sockets may be seen. The emargination of the sockets of the central incisors, and consequent enlargement of the alveolar apertures necessary for the evolution of the crowns of these teeth, having been accomplished, and the crowns having passed through, absorption is suspended, and the several alveoli becoming contracted, apply themselves to the teeth, and development at the margins keeping pace with the growth of the roots of the teeth. The socket of an incisor, so long as the crown is below the alveolar margin, is larger at its base than at its more external boundary; but no sooner does the crown leave the socket, than the relative dimensions reverse themselves. The base contracts, by the development of new bone, to the dimensions of the fang. The level of the socket is not, however, at present changed. If the comparison of the two subjects be continued, it will be seen that although the length of the ascending rami has considerably increased in the older jaw, yet that the angle formed by the two portions remains pretty much the same.

Twenty-one Months.—The differences observable between the preparation last described and the maxillæ of a female subject twenty-one months old, with the exception of a slight general increase in size, are confined to the more advanced condition of the teeth. The four incisors of either jaw have assumed the normal position; the crowns being fully exposed, although the fangs are not quite completed. The sockets have however contracted, and closely embrace the implanted portions of the teeth, at the same time that they have grown up with the teeth as the latter have increased in length.

The canines show only their tips above the alveolar margin; but the first temporary molars in the upper jaw have fully emerged, and are closely embraced at their necks by the margins of the sockets. In the lower jaw, these teeth have escaped from their sockets, but as the thicker part of the crown is scarcely through the aperture, the emargination of the edge of the alveoli has not been obliterated by development of bone at these points.

Twenty-eight Months.—In a twenty-eight-months' subject, in addition to the teeth which have been described as having taken their permanent position in the younger jaws, the crowns of the canines have partly passed out of their sockets, those of the upper being in advance of the corresponding teeth of the lower jaw.

Forty Months.—If we now pass to maxillæ from a subject forty months old, it will be seen that the whole of the temporary teeth have taken their normal position in the jaws, and appear complete; but if the roots are examined, the inaccuracy of this conclusion will be discovered. The incisors are the only teeth in which the fangs are completely formed. The canines are destitute of about one-third, the first temporary molars of a fifth, and the second temporary molars of at least one-half, of their normal length.

At this period a change takes place in the form of the jaw, and it may be regarded as the second epoch, at which this bone shows a more rapid rate of development towards the adult form. It was stated that within two months subsequent to birth, the angle of the lower maxilla became less obtuse; and in tracing the same point in jaws of progressive ages, it may be seen that but little further change takes place in respect

to the angle until the subject arrives at the third year. But at this age a manifest alteration may be observed. If a line be drawn along the alveolar margin, and across the ascending ramus, it will be seen that the angle formed by this line and the latter part is between fifty and sixty degrees; and that the articular and coronoid processes rise high above the alveolar line. It is important to observe how the angle has been diminished, as the recognition of this process of change will to a considerable extent elucidate the manner in which the adult is reduced to the peculiar form assumed by the jaw in advanced age. At the time of birth, the sockets are not deeper than the partially formed crowns of the teeth. The development of the sockets and of the teeth proceeds together, but the rate of growth is somewhat greater in the bone than in the teeth; so that the walls of the crypts rise above the contained teeth, and eventually arch over and protect them. When the crowns of the teeth are completed, the inverted edges of the sockets are absorbed, and reduced in height until they are lower than the teeth. The crowns of the latter gradually pass through the widened apertures of their respective sockets. When the portions of the teeth which are invested with enamel have passed the edges of the bone, development of the latter is resumed, and keeps pace with the increasing length of the teeth. Now, if attention be directed to the mental foramen at the several ages which have been noticed, it will be seen that from first to last this aperture is in close connexion with the terminal portion of the first temporary molar; indicating that the gradually increased depth of the jaw has been obtained by additions to the alveolar edge of the bone. If equal additions had been made

to the lower border, the relations between the body and the rami would have been maintained. But growth at that part is relatively slight, hence the angle formed by the two divisions of the jaws has become changed contemporaneously with rapid growth of the alveolar margin. The rami have been gradually elongated. The rate of growth is not, however, subject to sudden acceleration, as in the case of the alveolar border; a condition which is compensated by the increased depth of the alveoli, still further by the protrusion of the several teeth taking place at different periods in different parts of the jaws. If, for instance, the whole of the temporary teeth were cut at the same time, and the growth of the alveoli were equal throughout the whole line, the elongation of the rami must assume a sudden activity, otherwise the front part of the mouth could not be closed. With deficient length of the rami, the molar teeth alone would come in contact,—an abnormal condition not very rare in the adult, and to which I shall subsequently readvert. In the child, however, the eruption of the front teeth, and the subsequent rapid development of their alveoli, produce depression of the chin when the mouth is closed; at the same time the upper and lower gums, situated behind the front teeth, no longer come in close contact. The rami steadily increase in length, and after a time the back teeth appear through the gums, and occupy the space which has been gained, first by the separation occasioned by the prior development at the front part of the mouth, and afterwards increased by the lengthening of the rami.

By the uninterrupted but comparatively slow elongation of the rami, and the rapid but successive growth of the front and back parts of the jaws, a relation of parts is brought

about by which the whole series of teeth are allowed to be brought in contact simultaneously. If it were necessary to find a reason why the rami should not be subject to irregular rates of growth, similar to, and in accordance with, such as are seen to occur in the alveolar portions of the jaws, a sufficient reason might be found in the fact that bone which is developed in temporary cartilage under ordinary circumstances, increases steadily, and that the articular processes of the lower maxilla are increased in length by development in cartilage situated beneath the surface of the articular cartilage; the development in this situation offering no exception to what appears to be a general law in relation to the development of bone in temporary cartilage. On the other hand, bone may be formed with comparative rapidity upon a free surface of preexisting bone.

The more acute angle formed by the alveolar margin and the ascending rami in the jaw of the forty-months' subject, as compared with younger subjects, has been already mentioned. But if the line formed by the lower border of the body of the jaw be examined in relation to that bounding the posterior portions of the rami, it will be found that the angles formed are more obtuse, hence preserving at these points a greater similarity to the younger jaws; and the condition is maintained so long as the jaw continues to increase in length. The deep portion of the articular cartilage is to the articular portion of the jaw as regards growth, what the cartilage interposed between the epiphysis and apophysis is to a long bone. If, therefore, the lines last referred to were rectangular, as is the case in some finely-developed adult jaws, we might have a further increase in the length of the rami, and in the depth

of the jaws; but it would be difficult to see how the length could be increased in the horizontal portion.

At the age under consideration, the first permanent molar in the lower maxilla lies internal to the anterior portion of the base of the coronoid process; that is, supposing the jaw to be viewed from the outer side. The opening of the socket is contracted, of oval form, and directed upwards and inwards. Posterior to this opening we have the depression for the reception of the pulp of the second permanent molar, which at present lies upon the upper surface of the hinder part of the process of bone covering the first molar, a slight groove passing from the new to the older socket. In the upper maxilla we find a similar condition as regards the first permanent molar. The walls of the socket are strong; the aperture is small, and in a line with the alveolar margin, being directed downwards instead of downwards and backwards, as in the younger examples. On the posterior surface of the tuberosity a slight depression may be observed, connected, as in the lower jaw, by a shallow groove with the socket of the first molar. In this depression we have the earliest indication of a crypt for the reception of the pulp of the second permanent molar of the upper jaw.

Four Years and One Month.—The next specimen in my series was taken from a subject who died at the age of four years and one month. In these jaws, the incisor teeth are the only ones which are really perfected. The fangs of the others are slightly deficient in length, and are hollow at their extremities. Four or five additional months would probably have served for their completion. At the commencement of the sixth year the temporary teeth are all fully formed, a

condition which is most likely attained six months prior to this period; but I have not specimens of determined ages ranging between the fourth and fifth year suitable for the elucidation of the point. Seeing, however, that at the termination of the fourth year the development of the first set of teeth is not completed, and that at the commencement of the sixth year these teeth are perfectly formed, it may be assumed that at four and a half years of age the primary dentition is completed.

If the maxillæ of the forty-nine months' subject be compared with the one previously described, it will be seen that the slight depressions which marked the spots destined for the pulps of the second permanent molars, have now become large crypts with well-defined margins, the superficial extent being proportionately much greater than the depth. In the upper jaw these depressions look backward towards the pterygoid plates of the sphenoid bone: in the lower, upwards and a little inwards, their floors lying immediately over the inferior dental canal, near its commencement. Situated on the floor, near the posterior wall of the crypt, is a small foramen, which passes through into the dental canal, and gives passage to vessels which supply the developing tooth. Passing over the septum, dividing the sockets of the permanent molars, is the groove which in the younger specimen was but slightly marked. In this subject it is broad and strongly pronounced, the margins being raised into two thin processes of bone.

Having traced the progress of the temporary teeth from the time of birth up to the period of their completion, and the contemporaneous conditions of the jaws, the further changes

in form of the jaws will be resumed in connexion with the development and eruption of the permanent teeth.

In describing the different parts of individual teeth which may or may not hold the normal position, there is some little difficulty in writing intelligibly without first defining the precise meaning of the terms used. The teeth being placed in an ellipse, the terms *anterior* and *posterior*, if applied indifferently in describing the surface of an incisor and a molar tooth, would indicate different parts in the two teeth, and the confusion would be still greater when the teeth are altogether out of the usual position. In order to avoid this difficulty, arbitrary terms must be adopted and used without reference to the actual situation of any individual tooth, even supposing it be misplaced. Thus, the surface which normally is directed towards the lips or cheeks will be described as the *labial*, and that directed towards the tongue as the *lingual*, surface. The surface which lies against a neighbouring tooth, and is directed towards the point of junction of the two halves of the alveolar ridges, will be termed the *mesial* surface; while that which is directed outwards in the front, and backwards in the molar teeth, will be called the *distal* surface.

Irregularity in the position of the temporary teeth is seen in children whose jaws have not acquired the size necessary for the normal arrangement. The defect is, so far as I know, confined to the incisors, and may be limited to slight crowding and a consequent want of uniformity of position in several contiguous teeth. In three children, members of a large family, one of the central incisors of the lower jaw is in each

turned, so that the median side of the tooth stands in the position which should be occupied by the anterior or labial surface. The dentition in other respects is regular, both in these and in the brothers and sisters, although the jaws in each child are unusually small. A transverse section of a permanent central incisor of the lower jaw, when taken immediately below the enamel, gives an elongated oval, the long axis of which corresponds in direction with the median line of the mouth. Hence the turning of such a tooth in the jaw would only crowd to a greater degree the contiguous teeth. But the fangs of the temporary lower incisors are cylindrical, so that these teeth, when turned in the manner described, give greater room for those near them than would have been obtained had the normal position been preserved. Hence this deviation from the usual arrangement must be regarded as a means taken by nature to accommodate the want of concordance between the size of the teeth and the size of the jaws.

Irregularity in the number of the temporary teeth.—The number, order, and position of the deciduous teeth, as they arise in the jaws when the development is normal, have been described. The deviations from these conditions remain for consideration prior to entering upon the eruption, or cutting of the teeth, as the process is commonly called.

As regards the number, a child may have either more or less than the twenty. Instances are cited in which the jaws have been entirely edentulous. I have not had an opportunity of examining a case, either in the living subject or in a preparation. Recently I met with a gentleman who informed me that a member of his family, a female, about fifteen years

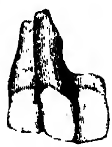
old, was then, and had been from the time of her birth, entirely edentulous, and that the lower part of the face preserved the appearance usually presented by a child prior to the eruption of the teeth. Such cases, however, must be extremely rare. A diminution in the ordinary number of temporary teeth is, however, not so uncommon. I have in my own collection two instances in which the lateral incisors are absent—one in which they are wanting in the lower (Fig. 12), the other in which they are absent in the upper, jaw (a view of which will be found in a subsequent figure). These cases of deficiency in the number of the first teeth possess but little practical interest, and, in a physiological point of view, we can do nothing more than recognise the bare fact. We are as little able to account for the absence of a temporary tooth usually present, as to determine why twenty, rather than a smaller or greater number, constitute the normal series.

The presence of teeth in excess of the usual number demands more attention, as we may in certain cases be called upon to determine whether or not they should be allowed to remain. I am indebted to Mr. Ibbetson for a cast taken from a case under his charge, in which there were five incisors in the lower jaw. They were uniformly arranged, and there was nothing peculiar in the form of either: so similar indeed were they, that it was difficult to determine which should be regarded as the supernumerary tooth. In my own collection, there is an upper jaw, the age of which is probably five years, having two supernumerary teeth. They are placed behind the central incisors, near the median line of the jaw; have conical crowns and roots, the latter being a little short of completion. Indications are present of their having passed through the

gum, or rather the palate, for they are situated posterior to that part which is usually designated gum. The circumstance that the other temporary teeth are fully formed, while these are not quite completed, might lead to the question, whether they should not be reckoned as supernumeraries of the permanent teeth; but examination of the latter shows that the enamel of the most forward of them is at present incomplete, and that the formation of the roots has not commenced. Hence it is fair to conclude, that the palatal teeth are supernumeraries of the first set of teeth. In this case it is quite possible that articulation was to some extent interfered with, and if so, their immediate removal would have been desirable.

Several years since, a child, aged five years, was brought to me, having a supernumerary tooth similar in character and in position to those last described. The tooth was removed in consequence of a difficulty in articulation, which arose contemporaneously with its appearance in the palate.

Fig. 19. (1)



Another case came under my treatment, in which the central and lateral incisors were united, and to these a third tooth was attached; this, the supernumerary, was united through the greater part of its length to the lateral. When the time arrived for the eruption of the permanent central incisor, the removal of

(1) Temporary teeth. The central and lateral incisors, left side of the upper jaw, together with a supernumerary tooth, united. The root of the central had been absorbed, and the permanent tooth was ready to pass out of its socket; hence the removal of the united teeth was necessitated. The patient, a female, was eight years of age. The other teeth were free from peculiarities.

the three became necessary. It was then seen that the root of the central incisor had been absorbed, but that the corresponding parts of the other two teeth retained their full dimensions. I have seen other instances of an unusual number of temporary teeth, but the excess has always been in the incisors themselves, or in their neighbourhood. Similar examples are recorded by many writers on the subject of dental surgery.

The temporary appear much more exempt from individual deformity than the permanent teeth. I have but one example. In this a strongly-pronounced conical cusp arises from the posterior surface of a central incisor.

Another deviation from the ordinary course of development remains for consideration, and which, like the preceding instances of departures from the usual laws, cannot be considered in connexion with those conditions which are attributable to disease. The pulps for the development of the individual teeth are not only distinct from each other, but are contained each one in its own crypt. Occasionally, however, the alveolar septum is absent, and two become laterally united, and the teeth produced from the adherent pulps form one mass, distinguishable from one another only by the presence of a more or less distinctly pronounced groove which marks the line of confluence. Sometimes the crowns of the teeth are more or less distinct, the roots only being united; while in others the crowns are united, and the fangs are to some extent separated. At the points of union the dentine is common to the two teeth, the cementum or the enamel, as the case may be, forming a common investment. This condition was known to M. Desirabode, who says, "The union

of the crown is a real fusion of the two teeth in which the ivory substances are common to each other." (1)

Mr. Salter has a paper in the "Transactions of the Medico-Chirurgical Society" upon this subject, and gives an illustration confirmatory of the fact advanced by Desirabode, but taken from two similarly united permanent teeth.(2) Mr. Brookhouse, of Manchester, sent me two examples of geminated teeth. The laterals and centrals are joined laterally throughout their length, and have a pulp cavity common to the two teeth. This was the more apparent in consequence of their removal (necessitated by caries) prior to the completion of their roots, thus affording an opportunity for a complete examination. A transverse section through one of the specimens, made immediately below the termination of the enamel, exhibits the common pulp cavity constricted at the point corresponding to the line of junction, and dilated at either extremity.

The central and lateral incisors, or the lateral incisors and canines, appear to be the only teeth of the temporary set subject to gemination. The accompanying figures illustrate the appearances presented by united teeth. (Figs. 20 and 21.)

The eruption or cutting of temporary teeth.—Having traced the growth of the temporary set of teeth in connexion with the jaws, from the time of birth up to the period of their completion, upon a series of preparations from which the soft parts had been removed, it is now necessary to consider the conditions of the latter so far as they are connected with the eruption of the teeth.

(1) American Journal of Dental Science, 1847.
(2) Medico-Chirurgical Transactions, vol. xxxv.

If we decalcify the lower jaw of a nine months' fœtus, and make a section through the gum and jaw, passing through one of the developing teeth, the tissues will be exposed in the following order:—First, we have a thick layer of epithelium, the cells of which are flattened, but gradually increase in thickness the further they are removed from the

Fig. 20. (1)

Fig. 21. (2)

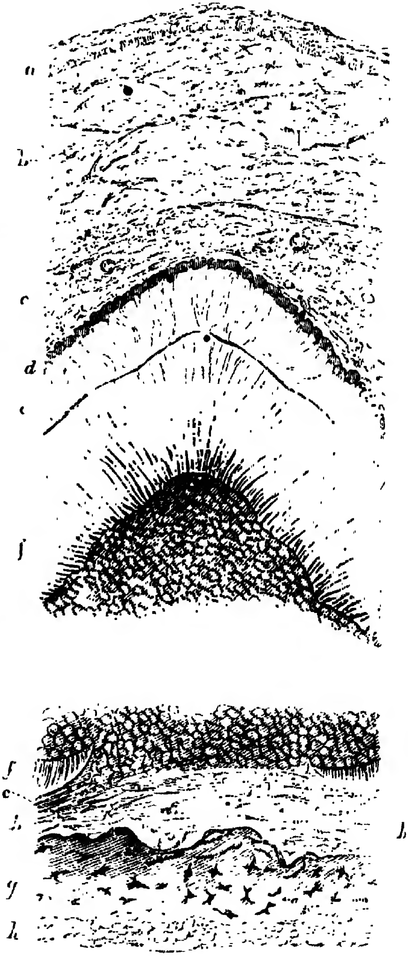
surface, and eventually terminate in a series of slightly elongated cells, the long axes of which are placed at a right angle with the surface of the gum. Below the epithelium comes a thick layer of stellate areolar tissue, the meshes of which are comparatively large and open. Nuclei are present in the centres of the stellations, while others may be found in fibres which have not conformed to the axial arrangement, or which, in progressive growth, have not yet arrived at the stellate form. In the meshes of the areolar tissue a few free cells may be found, but they are not abundant. Bloodvessels tra-

(1) Shows the front view of the lateral incisor and canine from the left side of the under jaw, united throughout their entire length, but with the line of junction well marked. The age at which they were removed was seven years. The corresponding teeth on the opposite side of the jaw were similarly united.

(2) Shows the representation of the lateral incisor and canine from the left side of the lower jaw of a patient aged nine years. In this example the line of junction is less distinctly marked than in the preceding illustration, and is altogether wanting near the base of the enamel.

verse this texture in considerable numbers. Near the lower boundary they become more abundant, are of larger size, and the tissue itself becomes more condensed. The fibres are placed nearer each other, and assume collectively the form of an ill-defined fibrous membrane, which dips down within the socket in the form of a sac—the sac or outer investment of the developing tooth. Still proceeding from above downwards, after passing through the upper part of the sac we come to the "enamel organ," then to the dentine and the dentinal pulp, which at its base merges

Fig. 22. (1)



(1) Showing the relative position of the tissues exposed in a vertical section through the lower jaw of a nine months' fœtus. *a*, series of elongated cells, forming the base of the epithelial layer; *b*, stellate areolar tissue; *c*, condensed tissue, forming dental sac, on the inner surface of which is the enamel pulp; *d*, the enamel organ; *e*, the enamel; *f*, the dentine, with the dentinal pulp; *g*, the bone forming the lower border of the jaw; *h*, the periosteum.

into the lower portion of the sac, without any definite line of separation or structural distinction between the two. Below this, again, we have a little loose areolar tissue which connects, although but feebly, the sac with the bony socket. Then comes the bone, which forms the base of the socket on the one surface, and the lower border of the jaw on the other; succeeded by the periosteum, which on its osteal surface is in great part formed of nucleated cells, the bulk of the membrane being made up of fibrous tissue, tending in character rather towards the stellate areolar tissue, than to the fibrous tissue of older subjects.

After the crown of a tooth has been formed, before it can be cut, the aperture of the socket must be enlarged, the coat of the sac immediately above the crown of the tooth removed, together with the superimposed fibro-areolar tissue and epithelial layer. These parts—which stand in the way of the eruption of a tooth—may, however, be removed in such strict accordance with the rate of growth and outward progress of the tooth—growth and waste may be so nicely balanced—that the subject of these changes suffers no inconvenience. In a child who was constantly under my own notice, tooth after tooth appeared without any premonitory symptoms. The period of teething came and went, attracting attention only when a new tooth was discovered. Instances of teething such as the foregoing are, I believe, comparatively rare, and can only occur in children who are and have been in all respects perfectly healthy, the fulfilment of which involves a series of conditions which our artificial state of living does not tend to bring about, or, it may be said, can scarcely allow.

Residence in crowded cities, even in members of the middle

classes, seldom fails to produce some amount of injurious influence upon childhood; and among the working classes, insufficient or improper food greatly tends to increase the evil which the want of a good atmosphere has been sufficient to create. Among the agricultural population we often find great crowding in the individual dwellings, a scarcity of animal food, and, by way of making the matter worse, a perfect indifference to the condition of the precincts of the cottages. A stagnant pond or a filthy ditch, into which is thrown the refuse from the house—one or other, or both, are found in most of our rural villages, within a few yards of the labourer's house. The almost universal presence, in one form or another, of these disturbing causes, is attended with a loss of that balance of the various functions of the body which constitutes perfect health. Hence we find that but few children pass through the period of teething without suffering. In some cases the attendant ailment is slight and unimportant; in others, maladies arise which endanger life. To these deviations from normal dentition, attention must now be directed; but in treating upon this part of the subject, I must borrow largely from the experience of others. The management of children during the eruption of the temporary teeth is seldom entrusted to those who confine their practice to dental surgery, and therefore their knowledge of the coincident disorders necessarily becomes limited and excused, a condition which has arisen within the last fifty or sixty years. Many of the earlier writers upon dental surgery were evidently consulted in cases where disease was supposed, correctly or otherwise, to arise from obstruction to the eruption of the temporary teeth

Dentition as a cause of local and constitutional disturbance.—In estimating the amount of influence dentition may have in the production of disease, those changes in the teeth, and in the parts connected with them, which I have endeavoured to describe in the foregone pages, must be kept in the mind; but not those only. There are other parts in the alimentary tract which in the healthy subject undergo concordant changes. Dr. West, in his valuable work "On Diseases of Infancy and Childhood," has brought together many of the facts which bear upon this subject, and I cannot do better than avail myself of his words:—

"The shape of the human stomach in the first month of existence approaches that which it retains through life in the carnivora, in whom the process of digestion is more simple than in any other mammalia. It is long, but little curved, growing narrower toward either end, where it passes into the œsophagus on the one hand, and into the intestine on the other. Its small curvature is but little arched, and approaches nearly to a straight line; the large curvature is but slightly developed, and runs almost parallel with the other,—characteristics which are all found in the stomach of carnivorous animals. Compare with this the form of the stomach in the adult. It is altogether more rounded: the œsophagus no longer enters at its left extremity, but nearly midway between that point and the pylorus. The pylorus itself is drawn back towards the cardia, and the two orifices are thus brought near to each other: hence the small curvature is very short; the great curvature of considerable extent, forming not merely the whole under part of the circumference of the stomach, but likewise bounding the whole of that pouch which is situ-

ated beyond its cardiac orifice. Besides this, too, the transition from the pylorus to the intestine is gradual in the child, while in the adult the demarcation between stomach and intestine is well marked. The result of all this is, that in the adult, who is an omnivorous animal, the stomach presents a form not unlike that which it has in some of the rodents—as the rat and the rabbit; and that the food, in the course of digestion, undergoes somewhat of a rotatory motion, not the simple onward movement which is communicated to it in the stomach of the carnivora. The stomach of the adult, then, is framed to act upon substances which may require some time for their digestion, while that of the infant is ill suited to retain matters long within it, and its small size unfits it for receiving much at once. If, therefore, the food given to an infant be such as can be digested with facility, it soon passes out of the stomach, and the infant speedily seeks for more. Nor are these arrangements, calculated for the rapid digestion of easily-assimilated food, confined to the stomach of the infant, but the form and proportions of the intestines correspond thereto: the small intestine is relatively shorter than in the adult; the large intestine of smaller calibre; the cæcum less developed; whilst the peristaltic action of the bowels is more rapid than in later life; excrementitious matters are quickly expelled, and the healthy infant passes three or four evacuations in the twenty-four hours."

Thus it is shown that while the organs of mastication are coming forward for use, the alimentary canal is at the same time assuming a form suitable for the digestion of substances that require to be masticated before they are passed into the stomach. And it may be assumed if the normal relations

existing between the dental and digestive apparatus, as regards their respective rates of development, be disturbed, that the child will become predisposed to disease.

The tables of mortality, under the head of death from teething, give over four per cent. of the whole number of deaths under the age of twelve months, and over seven per cent. between the latter age and three years. In these cases death is not, I presume, supposed to arise directly from disordered dentition, but from disease produced by teething. But before full credence is given to facts advanced in these returns, it should be shown that the disordered dentition is not itself a secondary affection, or that its cause was incapable of producing the fatal disease. I have not been able to find any account of careful post-mortem examinations of the teeth and jaws, in cases of death attributed to abnormal dentition. It should be shown, in individual cases the symptoms of which had been watched, in what particular the process of teething differed from the normal course—whether the crowns of the teeth being ready for eruption, the margins of the alveoli had not been sufficiently dilated by absorption of the bone to allow of their passage towards the surface of the gums, or whether the gums only impeded the eruption of the teeth; and moreover, that in the presence of other unnatural conditions, the dental was the primary affection—that it was, in truth, the first link in the chain of disordered actions. There can be but little doubt that difficult dentition has been overrated, as a cause of fatal disease occurring during the period of its presence. This has been strongly felt by Dr. West, who says:—

"The error which has been committed with reference to this matter, not merely by the vulgar but by members of our

own profession also, consists, not in overrating the hazards of the time when changes so important are being accomplished, but in regarding only one of the manifestations—though that, indeed, is the most striking one—of the many important ends which nature is then labouring to bring about. A child in perfect health usually cuts its teeth at a certain time and in a certain order, just as a girl at a certain age presents the various signs of approaching puberty, and at length begins to menstruate. In her case we do not fix our attention solely on the menstrual flux; nor, if it fail to appear, do we have recourse to the empirical employment of emmenagogue medicines. We examine into the cause of its absence; try to ascertain whether it depends on the state of the health in general, or of the uterine system in particular, and regulate accordingly our attempts at cure. The epoch of dentition is to be looked at just in the same way as that in which we regard the epoch of puberty. Constitutional disturbance is more common, and serious disease more frequent, at those times than at others; but their causes lie deeper than the tooth which irritates the gum that it has not yet pierced in the one case, or than the womb which has not yielded the due discharge of blood in the other. You might produce hæmorrhage from the uterine vessels in the latter instance, or might cut through the gum which enclosed the teeth in the former, with no other effect than that of aggravating the condition of your patient."

Dr. Copland gives the following definition of *Difficult Dentition*:—" Slow or retarded evolution of the teeth, with signs of local irritation and constitutional disturbance, often with disorder manifested especially in the digestive organs

and nervous system, occurring chiefly in weak or over-fed children." In describing the local symptoms I must again borrow from Dr. West:—

"Though a perfectly natural process, dentition is yet almost always attended with some degree of suffering. Many of us, no doubt, can remember feeling much pain when we cut our wisdom teeth, and children probably experience the same kind of annoyance. This, however, is not always the case; for sometimes we discover that an infant has cut a tooth, who had yet shown no sign of discomfort, nor any indication that dentition was commencing, with the exception of an increased flow of saliva. More frequently, indeed, the mouth becomes hot, and the gums look tumid, tense, and shining, while the exact position of each tooth is marked, for some time before its appearance, by the prominence of the gum; or the irruption of the teeth is preceded or accompanied by a somewhat different condition of the mouth, in which there are much heat, and intense redness of the mucous membrane, an extremely copious flow of thin saliva, and a disposition to the formation of small aphthous ulcerations on the tongue, at the outer surface of the alveolæ, or at the duplicature of the lip, though the gums themselves may not be particularly swollen or painful. Either of these states is usually attended with some degree of febrile disturbance, and apparently with considerable suffering to the infant, who is constantly fretful and peevish, or cries out occasionally as if in pain. A third morbid condition of the mouth is sometimes seen, which is usually ushered in or attended by very considerable fever and disorder of the chylopoietic viscera. The gums then become extremely hot and swollen, and unusually tender, especially

over some tooth or other in particular, and in that situation we find the gum swollen up into a kind of little tumour. Small unhealthy ulcerations, with a sloughy appearance, often form upon the summit of the gum, and especially around any tooth which has partly pierced through it. To this affection, which is often very painful, and often difficult of cure, the name of *Odontitis Infantum* has been applied by some Continental writers."

Many of these symptoms, according to Dr. Copland, frequently precede the appearance of the teeth by several weeks, but do not always maintain a uniform severity. Indeed, they may altogether subside and reappear before the teeth are cut. In such cases, the old nurses tell you that the teeth were breeding in the first attack, and in the second cutting the gums. A more probable explanation is, that in the one case they were passing through the alveolar openings—in the other, making their way through the gums.

Among the collection of infantile maxillæ which has been made, there are several specimens of local disorder which may be noticed at this point of the inquiry. In one example, taken from a subject nearly nine months old, the teeth present no obvious peculiarity either as regards structure or forwardness. The jaws are, however, small, and the bone is unusually porous, the alveoli being at many points imperfect, leaving the forming teeth partly exposed on their anterior surfaces. In a second specimen, twenty-one months old, a similar condition of the maxillæ exists. The incisors and first temporary molars have been erupted, and appear tolerably well developed. Nothing is known of the history of these cases, but surely the unusual condition of the bone of the alveolar processes must have

been attended with local indications of disorder. In a third specimen we have the enlarged cranium peculiar to chronic hydrocephalus, accompanied with an absence of the outer alveolar plate, so that the teeth are exposed over the whole of their anterior surfaces. The bone does not exhibit any unusual porosity, the defect being in quantity only,—a peculiarity which is extended to the whole of the bones of the face. (Fig. 23.) I saw a patient some months since, who

Fig. 23. (1)

presented similar conditions. The anterior surfaces of the teeth could be felt through the gums. The child was under the treatment of Dr. West, who tells me that he has observed in cases of this kind dentition is seldom attended with local irritation or any increase of the pre-existing constitutional disturbance. If this be a constant condition, it goes some

(1) View of the facial portion of skull of child who had suffered from hydrocephalus, showing the developing temporary teeth, and the defective anterior walls of the sockets.

way towards showing that the local irritation so commonly observed is consequent upon the obstruction offered to the eruption of the teeth by the margins of the sockets, rather than to that afforded by the gums. Further observation is required before the question can be set at rest. Indeed, this remark may be applied to the whole subject. Some practitioners attribute almost every ailment of infancy to dentition, without, however, attempting to explain how so much mischief is produced, contenting themselves with the general statement, without telling us in what particulars the series of changes which accompany the eruption of the teeth were defective. Other medical men entertain the opinions so clearly set forth by Dr. West.

In addition to the various characters presented by the gums, and which have been already noticed, there is a condition which I have seen in a few cases only. The gum of the coming tooth is enlarged, but the enlargement is circumscribed, has a blue or purple colour, and yields to pressure. If an incision be made into it, a small quantity of transparent fluid will escape, and we shall find the tooth at the bottom of the emptied cyst. In these cases, the enlargement apparent on the surface of the gum was obviously produced by the secretion of fluid between the surface of the enamel and the superjacent soft tissue. I was unable to determine whether the lining of the cyst was composed of the fibrous tissue which forms the base of the enamel-pulp, or of the stellate areolar tissue which lies external to the latter. There appears to be no connexion kept up between the enamel and the remains of the enamel-pulp when once the former is completed, and it is not improbable that a slight amount of fluid may be present as

a normal condition. The inconvenience experienced by the patients appeared to be very slight, and the occurrence of effusion in the sac would merit little attention, but that it offers a probable explanation as to the source of a disease which sometimes arises in connexion with the evolution of the wisdom teeth—a subject which will be considered in a future page.

Hunter, after stating that the teeth, in their advance towards the surface of the gum, exert pressure upon the superimposed parts, thereby causing inflammation and ulceration, goes on to say, "that ulceration which takes place in dentition is one of the species which seldom or never produces suppuration; however, in some few cases I have found the gums ulcerated, and the body of the tooth surrounded with matter; but I believe this seldom happens till the tooth is near cutting the skin of the gums." The condition here described is probably subsequent to the infiltration of serous fluid within the capsule investing the enamel.

The most common result of difficult dentition is a general febrile condition. Hunter says:

"The fever is sometimes slight, and sometimes violent. It is very remarkable both for its sudden rise and declension: so that in the first hour of this illness, the child shall be perfectly cool; in the second, flushed and burning hot; and in a third, temperate again."

Disorders of the nervous system frequently arise at this epoch, varying in intensity from slight muscular twitching to violent convulsions. The following case occurred in the family of a medical man:—A child, playing round the dining-room table, suddenly fell down in a state of insensibility.

The father at the time was absent, and a neighbouring practitioner was called in, who, on examining the mouth, found that the gum was raised, and in a state of tension over a temporary molar. An incision was made down to the tooth, the child immediately recovered its sensibility, and in a few hours was perfectly well. Now as no medicine was given, and as the insensibility was continued until the gum was divided, it would be too much to assume that the operation and the recovery had no further relation than mere coincidence, especially when it is remembered that the majority of those engaged in extensive general practice could furnish cases similar to the one cited above. On the other hand, we may have convulsions when teeth are about to be cut, and the gums may be lanced with no apparent advantage, the disease running its course towards recovery or death, uninfluenced by the dental operation.

Hunter—whose work on the teeth cannot be too often referred to by those engaged in the practice of dental surgery, or in the treatment of disorders coincident with an abnormal state of the dental apparatus—states: "The partial or local consequential symptoms are the most varied and complicated; for the appearance they put on is in some degree determined by the nature of the parts they affect; wherefore they imitate various diseases of the human body. These symptoms we shall describe in the order of their most frequent occurrence: *Diarrhœa*, costiveness, loss of appetite; eruptions on the skin, especially on the face and scalp; cough, shortness of breath, with a kind of convulsed respiration, similar to that observed in hooping-cough; spasms of particular parts, either by intervals or continued; an increased secretion of urine, and some-

times a diminution of that secretion; a discharge of matter from the penis, with a difficulty and pain in making water, imitating exactly a violent gonorrhœa."

A case is given in which this disturbance of the urinary organs was invariably coincident with cutting of teeth, the one as it were keeping time with the other. Hunter's own words are: "It was observed at last, that they (the urinary symptoms) returned only upon his cutting a new tooth; this happened so often, regularly, and constantly, that there was no reason to doubt but that it was owing to that cause."

Here, then, we have, on the highest authority, a long list of the many ailments that *may* be consequent upon disordered dentition; and it is for the practitioner to distinguish in individual cases, whether the disease present during the time of teething is consequent upon some derangement of this process, or upon an abnormal condition of some other organ or organs, of which the dental difficulty is but itself a symptom. In forming this distinction, the state of the jaws must be the principal guide. If, in the presence of symptoms which might arise from teeth, we find that teeth are not pressing forward towards the surface of the gums, and that the latter maintain their normal appearance, it will be useless to have recourse to the gum lancet; yet even in this case, the disorder may be due to, or much influenced by, the teeth. They may be confined by the sockets, a difficulty beyond the reach of mere division of the gum. It is not easy to see how wounding the superjacent soft tissues should promote absorption of the osseous margins of the sockets; yet there are those who, on all occasions, have recourse to this practice.

There are, however, cases in which this simple operation

will at once either mitigate or entirely remove most alarming symptoms; but in such we shall find the gum prominent, and in a state of tension over the advancing tooth. Under these conditions the gum should be divided down to the surface of the tooth, and not at a point only, but across the whole breadth or length of the crown; in fact, the imprisoned organ should be entirely set free.

Then, again, there are cases in which the gums may be lanced with advantage, for the sake of local depletion, without reference to the liberation of the teeth. When we find the part inflamed and painful, this measure may be adopted: the incisions should not, however, be deep, as in the former case, but superficial only, and performed with a sharp instrument, shaped like an ordinary lancet, and with an equally sharp edge. The indiscriminate adoption of this treatment in all cases when the gums are turgid and inflamed will occasionally lead to mischievous results. In children who are enfeebled, either from disease or residence in a bad atmosphere, ulceration of the wounded parts may follow as a consequence of the operation.

For a detailed account of the symptoms and treatment of those diseases which may be occasioned or aggravated by abnormal dentition, I must refer the reader to works treating upon the diseases of infancy and childhood. These are subjects which seldom come under the notice of the dental surgeon; he, having his attention constantly directed to the organs of mastication in all their varied conditions, should be able to point out any deviation from the normal state of the teeth and jaws with greater precision than those whose practice ranges over a wider field. The conditions necessary

to the acquisition of this special knowledge preclude the possibility of his gaining an amount of practical information upon the general subject of disease sufficient to place him upon an equality with those who devote themselves to the study of the diseases of infancy and childhood.

Relations of the temporary to the developing permanent teeth at the period when the former are fully formed.—In following the plan which has been adopted in arranging the matter of the present volume, it will be necessary to point out the normal relations of the two sets of teeth before entering upon the irregularity in the arrangement of the permanent organs while still within the alveoli. If we select for examination perfectly well-formed jaws from a subject in which the first permanent molars have not appeared through the gums, but in which the temporary teeth are all perfect, we shall find that each member of the latter set has become slightly separated from its fellow; a condition indicating that the growth of the jaws has been in all respects normal, and consequently that a good and well-arranged set of permanent teeth may reasonably be expected.

The crowns of the permanent incisors, both of the upper and lower jaws, are perfected, excepting perhaps at that part where the enamel terminates. There the dull and chalk-like appearance which that tissue presents when the development is progressing, may be observed. The canines are still less advanced, while the crowns of the first bicuspids have not attained to more than two-thirds, and those of the second bicuspid not more than a third, of their ultimate lengths. The crowns of the first permanent molars are, as respects their external surface, fully developed; and the septa of dentine

which extend across the base of the pulps marking out the several roots yet to be developed are fully pronounced. The second permanent molars are at present represented by about two-thirds of their crowns, and invested with a thin layer of partially-developed enamel. The positions of the pulps of the wisdom teeth are but faintly indicated by slight depressions in the bone posterior to the sockets, which contain the forming second molars. These marks may, however, at this period, be altogether wanting.

The position of the temporary teeth in the jaws differs from that of the permanent set in being perfectly vertical. The crowns do not occupy a more forward position in the dental circle than their respective roots; the crown of each tooth is directly over or under (as the case may be) its own root, the latter standing immediately in front of one or other of the succeeding teeth.

The permanent teeth are at this age contained within bony cells, which have been aptly enough compared to the dense layer of shell which surrounds an almond, and which, like the dental cells, is connected with the contiguous tissue by a comparatively porous structure. The alveolar cells may be readily isolated by breaking away the porous bone by which they are surrounded, except at those points where they come in contact, and blend with the dense bone which contributed to form either the outer surface of the jaw, or the dense wall of a neighbouring cell.

On removal of the bone from the anterior surface of the maxilla, it will be seen that the permanent central incisors are placed nearly parallel with each other, the cutting edges in the upper teeth being inclined a little forwards, while the

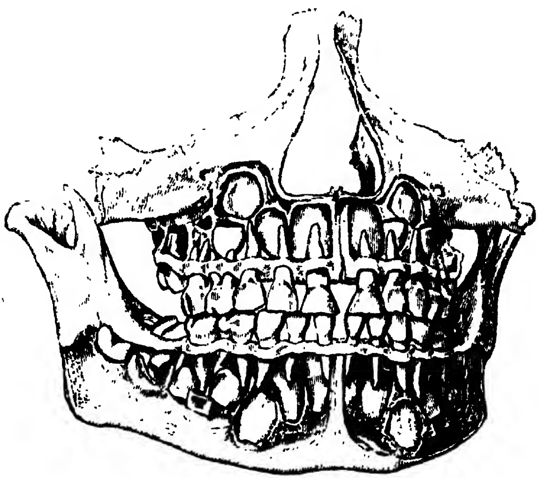
parts corresponding to the base of the crowns of the two teeth respectively are placed immediately below the floor of the nose, from which cavity they are separated by a thin layer of bone only. The teeth at this stage of growth completely fill the cells or crypts. The corresponding lower teeth hold a similar position in the lower jaw, but have a strictly vertical position, and show a slight advance in development as compared with the upper centrals.

The lateral incisors of the upper jaw have a slightly oblique direction, the cutting edges being more forward than the base of the crowns, which are nearly on a level with the correspondir parts of the central teeth. The labial surface of each is ofte. slightly turned, so that the mesial surface which lies against the central incisor is directed outwards, while the mesial angle of the tooth stands in front, and a little over the contiguous portion of the central incisor. The point at which the one tooth overlaps the other, corresponds to the position of the root of the temporary lateral incisor. That side of the lateral which in the perfected teeth lies against the canine, here rests against the cell which contains the first bicuspid; while the developing canine is at this period above the latter tooth. In the lower jaw the lateral incisors are placed less regularly, holding a position slightly more backward than the centrals. The tooth of either side is turned from the mesian line, and lies obliquely over the canine, to the extent of about half of that tooth. They do not, however, as in the upper jaw, come in contact with the cells that contain the first bicuspids.

The permanent canine teeth at this stage of dentitic situated above the line of the other teeth in the upp below it in the inferior maxilla. Those of the upper ja

directed slightly forward and outwards, while in the lower jaw these teeth have a direction upwards and a little inwards. The bicuspids are placed in cells situated between the roots of the temporary molars.

Fig. 24. (1)



In the specimen which I have chosen for description, and from which the illustration is taken, we have perfectly well-grown jaws, showing very completely the relations in position of the first to the second set of teeth, and the relative position of the several members of the latter to each other. It is very desirable that the practitioner should be well acquainted with the conditions which this, in common with many other illu...

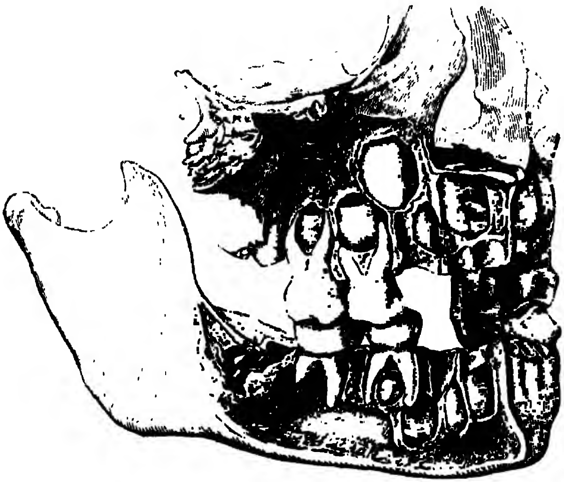
are ... in t...

(1) ...hows the relations of the temporary and permanent teeth at the ... when the former are perfectly formed, in an example of well-formed ...

similar specimens, presents. We see in it all the early conditions necessary to the development of a perfectly regular set of teeth fulfilled.

In another specimen (Fig. 25), the arrangement is equally normal, but differs in one respect from that which has been described. In this case the mesial sides of the upper lateral

Fig. 25. (1)



incisors are placed behind the distal sides of the central teeth. The degree of overlapping is perhaps rather in excess of what may be regarded as a perfect arrangement, and the lateral have descended nearer to the alveolar margin than the central incisors; but still the specimen will serve for illustrating the relative position of the several teeth alluded

(1) **Showing the relative position of the two sets of teeth, with the upper lateral incisors descending lower than the central teeth, and the right lower lateral with its distal edge turned outwards.**

to, at the same time that it exhibits an irregularity in the position of the right lateral incisor in the lower jaw. This tooth has its median edge turned outwards towards the lips, and is accompanied with a diminished size of the anterior part of the jaw, as compared with many other jaws of similar age.

Attention may again be directed to the fact that the temporary teeth are placed vertically in the jaws, and that if their successors were similarly implanted, there would not be room in the upper jaw for the canine teeth. But the upper incisors in the place of a vertical have an oblique direction forwards and outwards towards the lips, while the vertical line is at this age followed by the bicuspids. Now, if we produce an imaginary line through the axes of the upper incisors in their present state, to the extent of perfected teeth, it will be seen that the difference in the direction of the line of growth between the incisors and the bicuspids will lead to a separation between these teeth sufficient to admit the canine into the dental line. In order that this result shall be attained, it is necessary that the relative rate of growth between the several teeth shall remain undisturbed. If, for instance, the canine advances too rapidly upon the lateral incisor, and makes its appearance through the gum before the lateral tooth has advanced sufficiently forward and outwards, both teeth will be displaced: the lateral will be forced within the proper line, and the canine will occupy a place external to it.

Many children, however, either from hereditary tendency or from ill-health and consequent defective growth in the jaws, have the permanent teeth during their development placed irregularly. Attention has already been directed to the fact that the size of the crowns of the teeth is determined

at an early age, and is not capable of subsequent alteration. It would appear, however, that a want of proper relation in respect of size between the teeth and the jaws may become a permanent hereditary character, quite apart from the influences of health and disease. In certain families we may see large teeth associated with small jaws, the want of the requisite size in the latter parts necessitating the removal of two or more of the permanent teeth before the regular arrangement of the remaining ones can be assumed—and this without any indication either of want of constitutional vigour, or of predisposition to disease. It is, in fact, a peculiarity transmitted from parent to child, and must be regarded rather as an hereditary characteristic, than as an abnormal condition resulting from an arrest in the development of the maxillæ, capable of amendment if the patient be subjected to treatment during the period of childhood. It is very necessary that this part of dental surgery should receive far more consideration in an anatomical and physiological point of view than it has hitherto done. In the absence of precise knowledge upon the subject, there is room for great disparity of opinion as regards treatment, leaving a wide and very productive field for the cultivation of the charlatan, who sees in every case of irregular disposition of the teeth an opportunity for mechanical interference, in some cases securing to himself a large fee for doing by means of mechanism that which Nature would have effected, had the opportunity been allowed; and in other cases submitting the patient to a long course of treatment, which entails no useful result.

In the subsequent pages, an attempt is made to bring together a series of conditions connected with the subject of

irregularity of the permanent teeth, taking up the inquiry at an earlier period than is usually done, and tracing the deviations onward until the teeth are matured.

Irregularity in the position of the permanent, during the existence of the temporary, teeth.—The first example selected for description in illustration of irregularity in the position of the permanent teeth, will be that of a child who died when a little over the age of four years. The temporary teeth in the front part of the mouth are crowded, the mesial edges of the lateral incisors of the upper jaw being directed forward, from insufficient space for a more regular position of these teeth. The permanent central incisors, although uniform as regards each other, hold an unusual position. The mesial edges are turned forward, and the cutting edges of the teeth, from the obliquity of the crowns, are directed towards the mesial line. The upper lateral incisors lie in front of the distal edges of the central teeth, and the canines are placed immediately over the roots of the first temporary molars, and consequently immediately over the developing cusps of the first bicuspids. We have in this case a deranged position which, until the teeth have passed through the gums, cannot be materially changed. The development of the teeth has been continued while the jaws have been comparatively stationary. The oblique and twisted position of the central incisors will be maintained until they are acted upon by the antagonistic teeth of the lower jaw; and the first bicuspids, which have been encroached upon and retarded in growth by the canines, will be crooked and misshaped, at the same time that they will be forced into an irregular position in common with the impinging canines, leading probably to one or other of the

permanent forms of displacement of the later teeth, considered in a future page. In this case, the teeth in the lower jaws are subject to but slight irregularity.

Fig. 26. (1)

In another specimen, from a subject who died at the age of four years and thirty-six days, the lateral incisors of the upper

Fig. 27. (2)

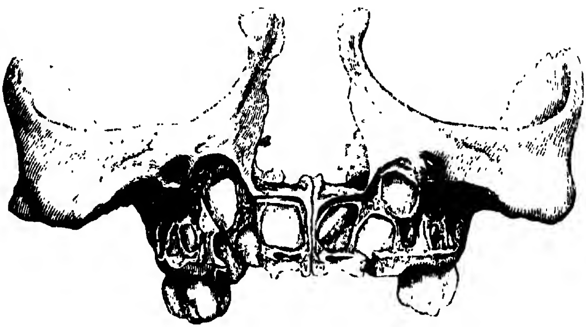
(1) Showing the permanent central incisors, with their median sides directed forward and outwards, while the distal edges lie behind the median sides of the laterals.

(2) Side view of the same specimen, showing the relative positions of the central and lateral incisors, the canine and the first bicuspids, the latter tooth being interrupted in its development by the canine.

jaw are placed behind the centrals, the latter teeth and canines being separated only by the common wall of their respective crypts.

In a third specimen, the mesial surface of the left upper central is turned outwards, while the corresponding part of the fellow tooth is turned inwards. The mesial side of the left lateral incisor lies in front of the distal side of the central, and on the opposite side of the jaw the mesial side of the lateral is placed behind the distal side of its contiguous central tooth. The canine and bicuspid teeth hold the normal position.

Fig. 28. (1)



In a fourth specimen we have an arrangement of teeth which may not unfrequently be seen in the adult. The deviation from the natural form is but slight, yet gives a very characteristic appearance to the mouth, and one which indicates a want of activity in the growth of the jaw during

(1) Shows mal-position of the incisors. The left central has its median edge turned outwards, with the lateral lying in front of the distal edge. The right central incisor has its distal side everted, with the lateral placed behind.

childhood. In this the distal sides of the upper centrals are slightly everted, while the crown of each tooth, regarded in its length, slants outwards from the mesian line. Usually, the upper and smaller parts are separated by a wider interval than the lower portions of the crown; in this case the mesial surfaces are parallel throughout the whole length of the crowns. Hence the eversion.

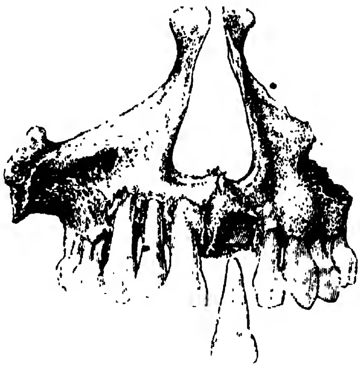
Fig. 29. (1)

Hitherto, the relations of the teeth to each other and to the jaws, have been considered in cases where the maxillæ present the normal structural appearance, as distinguished from cases in which there are obvious marks of a diseased condition of the bone. In the specimen from which the two succeeding figures are taken, the bone is defective both in the quantity and in the quality of the tissue. The temporary teeth are almost devoid of sockets, while the developing permanent

(1) Shows the centrals symmetrically arranged, but with the distal side of each tooth turned slightly outwards.

teeth—in the absence of sufficient bone to admit of the existence of normally-formed crypts—are covered at certain points by soft parts only. The subject—a male—from which the maxillæ were taken, died exhausted by strumous abscesses when he was said to be six years old. Both in the upper and lower jaws, the incisors and canines are almost without sockets, and the molars have but imperfect ones. The general dimen-

Fig. 30. (1)



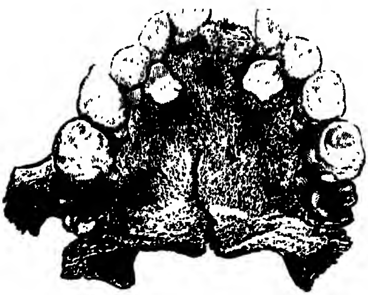
sions of the jaws, even supposing the age to be overstated to the extent of eighteen months, are a third below the normal size. This has led to the mal-position of the permanent teeth. The central incisors of the upper jaws are of the usual size and shape, although the enamel is at certain points defective.

The canines lie with their median surfaces in contact with

(1) Front view of the upper jaw of a male subject who died at the age of six years, showing a defective condition of the outer alveolar plate and an imperfect implantation of the temporary teeth.

the distal sides of the central teeth, leaving no space whatever for the lateral incisors. These are placed within the dental line, behind the temporary canines (Fig. 31), lodged in very imperfect crypts, and placed at right angles to their proper position, the cutting edge of each tooth being directed outwards instead of downwards. The first permanent molars have their crowns nearly perfected, and are placed with the masticating surfaces directed obliquely backwards, the base of the crown running over the fangs of the second temporary molar, and encroaching upon the space which should be occupied by the second bicuspids.

Fig. 31. (1)



The second permanent molar, the cusps of which are calcified and united the one to the other, is altogether without an osseous receptacle.

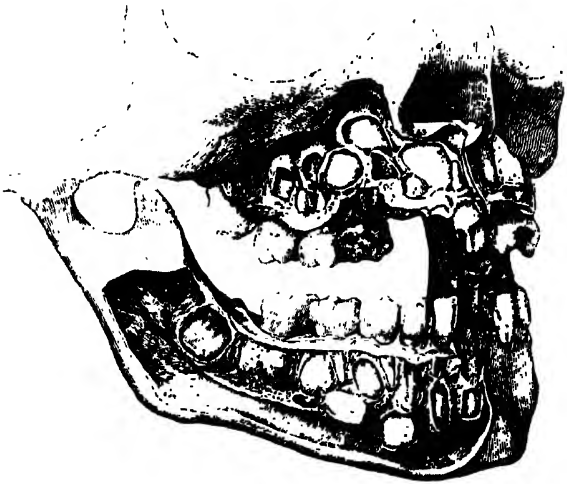
In this specimen we have a remarkably good example of

(1) Palatal view of the specimen illustrated in the last figure, showing an abnormal condition of the bone and the exposure of the permanent canines.

the effects produced from the development of the maxillæ having been suspended, while that of the permanent teeth was continued. We here see the great amount of displacement that may arise from the presence of long-standing constitutional disease.

Local disease in the temporary may also affect the permanent teeth; but the effect will be limited to those in the immediate neighbourhood of the disease. Caries, and consequent alveolar abscess, arising in a temporary tooth, sometimes produces injurious effects upon, and even displacement of the

Fig. 32. (1)



(1) The upper and lower jaws at the age when the permanent incisors are about to appear through the gums, showing the relative position of the two sets of teeth. The left lateral incisor of the upper jaw is imperfectly developed, and placed external to the central tooth; and the first bicuspid of the same side has been forced outwards by disease, and subsequent death, of the preceding temporary molar.

succeeding tooth; and this is, I think, a more frequent consequence when the disease is situated in the first or second temporary molars, than when the front teeth are affected. In a preparation figured to illustrate the effects of dead teeth, it may be seen that the developing first bicuspid of the upper jaw has been driven outwards by the mischief arising from the presence of a dead temporary molar. (Fig. 32).

Disease in a temporary tooth will, however, sometimes set up inflammation, which in a strumous or enfeebled subject may spread, and ultimately involve a large portion of the jaw, and result in necrosis. The teeth, whether permanent or temporary, implanted in the sequestrum, are usually lost. Mr. Oliver Chalk relates several cases in which portions of the jaw, including the temporary and the crypts of the permanent teeth, were lost. New bone eventually took the place of that which had been removed, and the jaw again became perfect. In several of these cases, permanent teeth most unexpectedly made their appearance, suggesting the idea that the teeth, as well as the bone, had been reproduced. In each instance in which this unusual result occurred, the sequestrum was allowed to become perfectly separated and quite loose, before its withdrawal through the opening which already existed was attempted. The phenomena, as respects the teeth, admit of explanation on other grounds than that of supposing a second series of permanent teeth to have been developed.

Dead is in all cases detached from living bone, by absorption of the layer of the living tissue which connects the two; in addition to which, we commonly find marks of absorption scattered over the whole of that surface of the sequestrum which

has been connected with the soft parts. Again, the apertures of the crypts are by the same process greatly enlarged. The connexion between the walls of the crypt and the sac of the developing tooth-pulp is in the normal state but a slight one; and this, in the character of cases referred to, may be rendered still more slight by the presence of disease. Now, in the presence of the foregoing conditions, it is not improbable that the pulps of the permanent teeth remained attached to the soft parts, while the crypts included in the sequestrum were removed; and if such were the case, the developing teeth might again be surrounded by newly-formed bone. The truth of this explanation of the manner in which the peculiar results were brought about, is rendered probable by the absence of any well-authenticated cases of the occurrence of a second set of permanent teeth.

But whatever explanation be adopted, I think all will agree that it is desirable in those cases where necrosis of the jaw occurs during the presence of the temporary teeth, that the sequestrum should be allowed to remain until it is perfectly detached both from the contiguous bone and soft parts, before its withdrawal is attempted; and that its removal should be effected with the least possible injury to the latter, so that the permanent teeth, if not destroyed by the disease, may be placed under the most favourable circumstances for their future growth and evolution.

In addition to the causes already enumerated, mechanical injury of the maxillæ or of the temporary teeth, may be cited as producing displacement of the permanent teeth while lodged within the dental crypts.

Among mechanical causes, the extraction of temporary

teeth may be placed. We have most of us seen examples where removal of the second temporary molar has been accompanied by that of the partly-formed second bicuspid; an accident which has arisen either from the unusual convergence of the roots of the temporary, or from the absorption of the walls of the crypt of the permanent tooth. The latter condition is not, I think, extremely rare in those cases where alveolar abscess is consequent upon disease in the temporary molar. A certain degree of inflammatory action of the soft parts in the immediate vicinity of bone, leads to more or less absorption of the latter; and at the same time the former become glued together by effused lymph. Supposing these conditions to prevail, it will not be difficult to conceive how, in attempting the extraction of one, both teeth may be removed.

Taking the phases of dentition in the order of their occurrence, the next point which presents itself for consideration is the absorption of the roots of the temporary teeth.

Shedding of the temporary teeth.—No sooner is the temporary set of teeth fully formed, than a process is set up for the removal of some of its members. Within twelve or eighteen months of the completion of the roots of the second molars and canines, the fangs of the incisors are attacked by absorption.

The destruction may commence on any part of the root, or at several spots simultaneously. Particle after particle is by degrees carried away, until nothing but the crown of the tooth is left, and even this is often so much hollowed out, that little save the enamel remains, and sometimes not all of that.

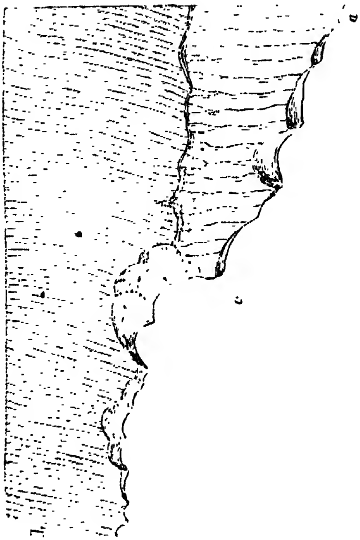
Although among a number of temporary teeth we may find that absorption has commenced at several and distant points,

and not uncommonly on the labial surface of the root; yet, in the majority of cases, that part which lies nearest to the growing tooth will be the first to show indications of wasting, and upon which the process will be the most active. The opposed surfaces of the roots of the lower temporary molars, embracing bicuspids, are acted upon, while the outer surfaces usually escape. The lingual surface of the fang of a front tooth is commonly attacked, the process commencing at or near the extremity; but the proximity of the permanent tooth is not by any means the point necessary. I have examined many specimens, in which a portion of the labial surface midway between the neck and the point of the root has been carried away.

Having latterly had occasion to devote considerable attention to the phenomena attending the absorption of bone and the wasting of the roots of the deciduous teeth, several conditions relative to absorption have come under my notice, which, as applied to teeth, had, I think, hitherto escaped observation. The cementum is first attacked, then the dentine disappears, and the enamel at those points where the dentine has been entirely removed suffers from the same action. But whichever of the three tissues is attacked, we see the same characteristic surface as that shown by bone when undergoing a similar action—namely, a surface full of deep indentations, as though they had been made by a sharp piercing instrument, having a semicircular extremity. These minute holes or depressions proceed in various directions, several advancing from contrary points towards the same spot, not unfrequently isolated pieces of dentine. If a section be taken through the substance of a tooth, so as to cut the wasting

part at a right angle, we shall find the surface acted upon to have an irregular festooned outline, so characteristic in appearance, that when once seen it cannot fail to be again recognised.

Fig. 33. (1)



Closely applied to this surface a cellular mass will be found, which is but slightly adherent, the wasting and growing surfaces readily parting, unless the two are held together by the irregularities on the surface of the former. It will sometimes happen that the cellular mass penetrates into the dentine through a small opening, and there dilates, in which case its withdrawal becomes impeded. This condition is now and

(1) A section from a temporary tooth, in which the dentine (*a*) and the enamel (*b*) have been removed by absorption, leaving the festooned outline (*c*).

then found in sections prepared for examination, and affords a favourable opportunity for examining the two tissues *in situ*. Indeed, we may find a few cells adherent to the surface of the dentine where less deep burrowing has occurred. By the aid of the microscope, the structure of this peculiar organ can be determined. The surface is made up of peculiar multiform cells, each one being composed of several smaller cells, the number varying from two or three to as many as fourteen or fifteen. The form is variable, but egg-shaped or spherical figures are found to prevail, although some few

Fig. 34. (1)

deviate from these forms, and offer a very strong resemblance to those cells described by M. Kölliker as myeloid cells.

The relation the more superficial of these cells bear to the wasting surface of the dental tissues is peculiarly interesting. It has been already stated that the surface of the papilla is closely applied to the wasting surface of the tooth; and in favourable specimens it may be shown that the individual indentations correspond to, and are occupied by, these large

(1) Shows the compound cells which form the surface of the absorbent papilla.

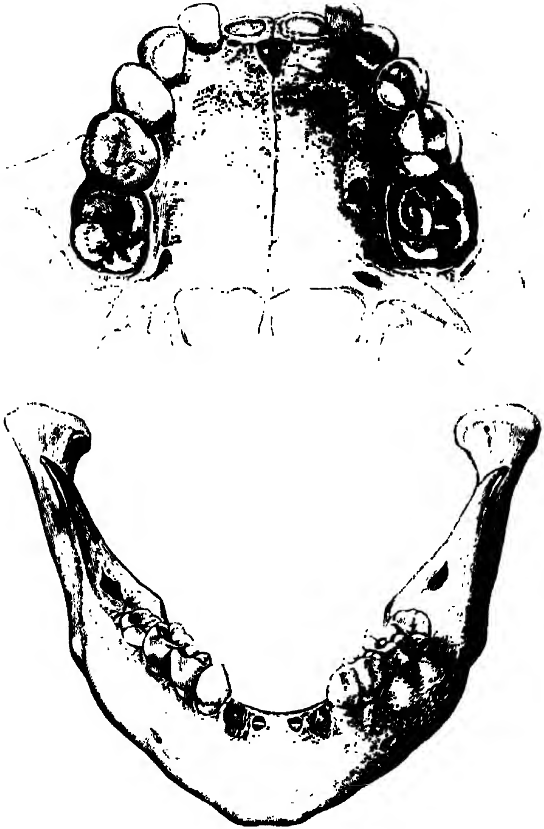
cells. On several occasions I have obtained specimens in which the two retained their natural positions. Each semicircular indentation in the dentine was occupied by a compound cell. Very possibly in other cases several cells may take the place of a single cell. Below the surface the papilla is made up of ordinary nucleated cells and free nuclei, similar to those contained in the superficial compound cells; while at and near the base, the tissue assumes the characteristics of developing fibrous tissue.

If a tooth which has lost its fang be carefully removed, we shall find remaining in its place the growing papilla, corresponding exactly in size and form to the surface from which it has been separated; and this separation may often be effected with so little injury, that no blood appears upon its surface after the operation, although the organ is highly vascular and readily torn. (1) The superficial extent of the papilla will be equal to that part of the tooth undergoing waste, but the extent, as regards depth, is slight; for, as the root of the tooth disappears, the socket is contracted by the deposition of bone, which forms at the base of the absorbent organ as rapidly as the cellular surface encroaches upon the tooth. The cases in which we find an exception to this condition are those in which the permanent has advanced close to the fangs of the temporary tooth, when the crypt containing the one communicates with the socket of the other, indicating that the rate of growth of the permanent, has been equal to if not greater than the absorption of the deciduous, organ. But

(1) Laforgue and Bourdet recognised the presence of the absorbent organ, but supposed it exhaled a fluid capable of dissolving the roots of the temporary tooth.

even in these cases we may occasionally observe some part in which the contraction of the socket has been coincident

Fig. 35. ([1])



([1]) The upper and lower jaw of a female subject, six years and five months old, showing the layer of bone which forms the bottom of the socket of the temporary incisors after the roots have been absorbed.

with the absorption of the occupant fang. From the following quotation, it does not appear that Mr. Bell observed these conditions :—

"It has been already stated, that the permanent teeth during their formation are crowded together in the jaw, by being placed in a smaller arch than they would occupy if regularly placed side by side. As the latter, however, is their destined situation, we find that as soon as they are advanced to a certain point of their formation, and can no longer be contained within the alveoli, absorption takes place in the anterior parietes of the cavities, by which means the teeth are allowed to come in some measure forward. In consequence of this absorption it often happens, that not only the socket of the corresponding temporary tooth, but that of the tooth on each side, is also opened to the permanent one. Absorption now commences in the root of the temporary tooth, generally on that part nearest its successor, and thus goes on by degrees as the latter advances, until the root is completely removed, the crown at length falls off, leaving room for the permanent tooth to supply its place."

Mr. Bell, however, rejects the idea that mere pressure of the one tooth against the other has anything to do with the absorption of the first set; an opinion that he would probably have expressed even more strongly, had he observed the shallow but perfect sockets which are formed when the temporary teeth are shed before their successors are ready to appear. This, however, must be a very common condition, as I have in my own collection several specimens illustrating the point.

The fact was not overlooked, I think, by Hunter, although his description is not very clear. He states, at page 99 in his

"Natural History of the Teeth:"—"The new *alveoli* rise with the new teeth, and the old *alveoli* decay in proportion as the old teeth decay; and when the first set falls out, the succeeding teeth are so far from having destroyed by their pressure the parts against which they might be supposed to push, that they are still enclosed and covered by a complete bony socket. From this we see that the change is not produced by a mechanical pressure, but by a particular process in the animal economy."

But there is still a disposition on the part of many who are entrusted with the treatment of teeth, to attribute the absorption of the roots of the one tooth to pressure occasioned by the growth of its successor, and the development of the permanent may have something to do with the shedding of the other. But this does not offer a satisfactory explanation of all the circumstances attending the absorption of the fangs of teeth. In the first place, we sometimes meet with cases in which the fangs of permanent teeth are as completely absorbed as those of the temporary organs. Then, again, the fangs of temporary teeth, which have no successors, are also absorbed. These circumstances, taken with the hitherto overlooked fact, that with the waste of the temporary tooth we have in many cases a corresponding development of bone within the socket to be removed before the permanent tooth appears through the gum, render the pressure theory altogether untenable. Another condition may be adduced, tending also against that opinion,—namely, that temporary teeth occasionally maintain their place to the exclusion of the permanent ones, which are then kept within the substance of the jaw, or appear in some unusual position.

The relations as regards time between the absorption and shedding of temporary teeth and the appearance of the succeeding permanent teeth, are by no means constant. In some cases the temporary teeth are thrown off two years before the corresponding permanent ones come through the gums. In others, again, the new will replace the old ones in as many weeks or even days.

Before the laws which regulate the absorption of the fangs of teeth can be fully recognised, a more perfect knowledge of the condition attending the process must be acquired. Recent examinations have enabled me to add the following additional facts bearing upon this subject to those already known. When the process of absorption has once commenced, it appears to have been assumed that the action would be continued, with more or less rapidity, until the tooth falls out. Such, however, is not constantly the case. Not only is the action of absorption suspended, but one of development takes its place. We find the excavated surface of the dentine, cementum, and enamel covered with cementum, the latter following all the irregularities of the former tissues, and closely united to them. (Fig. 36.) In cases where this development is going on, or in which the new tissue is retained, the teeth offer considerable resistance when their removal is attempted. In those instances where the first teeth have remained, and tend to the displacement of the second set, this deposit of cementum will be found to exist in considerable quantity.

The development of bone upon the surface which had formerly been the seat of absorption, by no means indicates that the tooth will not again be subject to destructive action. On the contrary, specimens in my collection show that the bone deposited under the above circumstances may itself

become the subject of absorption, that this process may be again suspended and development be renewed, that the absorp-

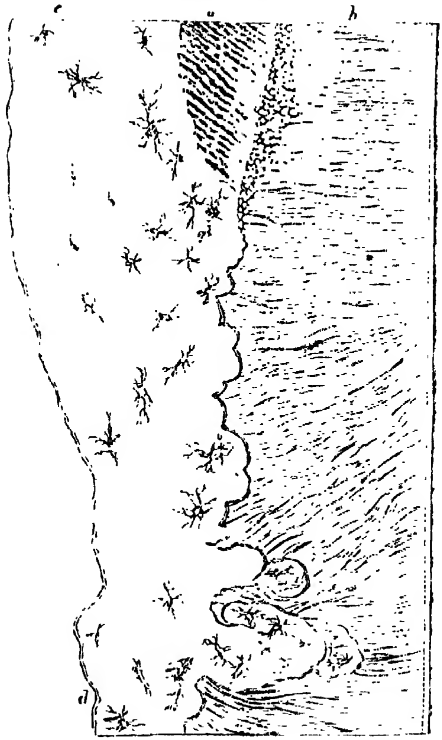
Fig. 36. (1)

tion may again take the place of development; in fact, that wasting and reparation may alternate until, by the preponderance of the former, the tooth is shed. In sections of teeth showing this peculiar condition of development, we may find upon the growing bone numerous osteal cells, with here and there a lacunal cell. A bone lacuna, situated within a semicircular indentation in the dentine, gives the appearance of a

(1) A section from the fang of a tooth in which the dentine (*a*) has been removed, together with the cementum (*c*), and again made good by the deposition of cementum. The appearance presented at the junction of the dentine and cementum, where absorption has not encroached upon the tissues at that point, is shown at (*b*). The curved irregular lines in the cementum indicate the extent of absorption at various periods, and the boundaries of the tissue which has replaced the lost parts.

lacunal cell, and a lacuna similarly situated in the cementum (a circumstance of common occurrence), has possibly been supposed by Mr. J. Salter to be what has been described in the paper before referred to as a lacunal cell.(1)

Fig. 37. (2)



(1) Transactions of the Pathological Society, vol. vi. p. 169.

(2) A section from a temporary tooth, the fangs of which have been absorbed, and the crown hollowed out; the enamel having been partly removed, and both tissues coated over with new cementum. *a*, the dentine; *b*, the enamel; *c*, the cementum; *d*, the junction of the absorbed surface of the enamel and new cementum.

The part of a tooth which has the greatest power of resisting absorption is that in immediate contact with the pulp. We find examples in which a thin shell of dentine encircles that organ, while that around it has been in great part taken away. This is, however, eventually removed, and the pulp itself changes its character, and becomes an absorbent organ, or makes way for that which is. In a fortunate selection we may find sections showing in one part dentine which has been but recently formed, with its modular outline and contiguous cells, capable of developing dentine; in another part, absorption in active progress; and in a third, the deposition of bone on the surface of the wasted dentine. In no instance, however, have I seen dentine deposited upon the surface of that which has been diminished by absorption.

It would appear that the dentinal pulp, although its function may be changed into that of absorption, or its place be taken by an absorbent organ, and this, again, changed to one for the development of bone, is incapable of resuming under any recognised circumstances its primary function of dentinal development. In other words, that a portion of dentine when removed by absorption, cannot be replaced; while in bone, or cementum, the renewal of a lost portion is of frequent occurrence.

It will be seen that the foregoing facts bear upon the opinions advanced by Mr. De Morgan and myself, in the paper on the structure and development of bone, before cited; that we have indications in teeth, as in bone, of alternations of removal and of deposition of tissue. In the young subject, the development of bone tissue is in excess of absorption, allowing the bones to increase in size; in middle life the two

powers, under ordinary circumstances, balance each other, and the bones preserve their adult dimensions; while in old age the absorbent action appears to preponderate. Conditions pretty nearly parallel occur in the dental tissues after the temporary tooth has been fully formed; portions of cementum are removed, and with them, in some cases, a little dentine; the lost parts are replaced by cementum, and the tooth is again perfect. When the time approaches for shedding the teeth, the two actions alternate; but the absorption being in excess of the development, the tissues disappear, and the tooth is shed. After the formation of the permanent teeth we have occasional alternations of the two actions; but they are balanced, and neither increase nor diminution in size is observed. But as age comes on, it often happens that absorption is in excess, the fangs diminish in size, the teeth become loose, and fall out.

The normal shedding of one or more of the temporary teeth is, however, sometimes subject to interruption. The absorption of the roots is suspended, and the tooth holds its place, while its successor is matured within the jaw in some unusual position, or where the permanent tooth is altogether wanting. It is not uncommon to find the temporary incisors firmly implanted, with the permanent teeth appearing through the gum behind them. In instances of this kind it is difficult to determine whether or not the permanent teeth were developed in a perfectly normal position, and their position subsequently changed by the persistence of the milk teeth consequent on the arrest of absorption, or whether the relative position of the two sets has been from the first irregular. Judging from the conditions presented in my own specimens, I should

incline to the opinion that the presence of the temporary teeth is in such cases due to some extent to original malposition of the developing permanent organs. Many instances in which the second temporary molars have been retained until the middle period of life has passed, have come under my notice. The second bicuspid has been wanting, and the temporary tooth has retained its original position.

The influence of the first and second sets of teeth upon each other at the time of replacement is so constant, and so varied in character, that it becomes impossible to treat fully of all that relates to the disappearance of the one, prior to entering upon the relations of the other. It will therefore be convenient to revert to several points connected with the shedding of the temporary (and especially those relating to treatment), in connexion with the eruption and arrangement of the permanent teeth.

Before we dismiss the subject of absorption, a few lines may be devoted to the consideration of the manner in which the absorbent organ is developed, and of the tissues from which it arises; both are points of great physiological interest.

In a paper read before the Odontological Society, Mr. Spence Bate advanced the opinion that the outer surface of the enamel organ assumed an increased degree of vascularity, and took upon itself the office of absorption. If our observations were restricted to the phenomenon as it is usually presented in the temporary molars, this opinion might, perhaps, be maintained; but when we find absorption commenced and continued upon the labial surfaces of the front teeth, where no enamel organ exists; and when we find a number of specimens in which a layer of bone separated the developing tooth from

the one undergoing absorption, considerable doubt is thrown upon the accuracy of Mr. Bate's views. He, however, considers the foregoing as exceptional cases, and regards them as abnormal. Any vascular tissue, on assuming an increased degree of vascularity, may, he considers, exercise the function of absorption. But the wasting of the fangs of permanent teeth, together with the class of cases cited above, he regards as instances of abnormal action, the absorption being performed by the peridental membrane, the vascularity of which has been increased by irritation at the same time that it has become detached from the surface of the tooth. The admission of this distinction into normal and abnormal absorption, in respect to the removal of the tissues of temporary teeth, will not, I think, help us to a better comprehension of the subject; for in the one case we cannot know when the action has commenced on a part distant from the enamel organ until the tooth has been removed, and in the other the septum of bone cannot be recognised but by dissection.

All recent observers will, I think, admit that the dental tissues are removed through the agency of the growing papilla, and I do not think a difference of structure or function, referable to the particular tissue from which it may have arisen, can be established. Whether the development takes place from the enamel capsule or from the peridental membrane, the structure and the function of the papilla will be the same. The recognition of the peculiar cells which form the surface, will throw some light upon the mode of growth. It is necessary only for the compound bodies to break up, and the liberated contents will be undistinguishable from the cells which form the central portion of the organ,

and the constant development of the superficial cells, and the subsequent liberation of the contents of those below the surface, would be equivalent to growth.

In a paper published in the "Philosophical Transactions," some of the foregoing facts are described in connexion with the absorption of bone, and an opinion was advanced, to the effect that the absorbent organ grew at the expense of the wasting bone or dental tissue, as the case may be. At that time the peculiar character of the superficial compound cells, and their correspondence to and lodgment in the minute concavities of the wasting tissue, had not been observed. But when it is considered that the dental tissue is decreasing, while the compound or mother cells (as they have been called) are increasing, and that the convexities of the latter are fitted into the concavities of the former, we are irresistibly led, not only to the conclusion that the growing papilla is the absorbent organ, but also to the belief that the superficial compound cells are the immediate agents by which the tissues are removed, and that the peculiar surface presented by either bone or dental tissues, is secondary to, and produced by the cells which form the surface of the papilla.

No doubt Mr. Spence Bate is right in asserting that the enamel organ, or I would rather say the outer surface of the capsule of the developing permanent tooth, may become the seat of the vascular structure which fulfils the office of absorption. But I am unwilling to admit that a similar structure arising in other parts and under other circumstances, is to be regarded as abnormal. Supposing the distinction to hold good, we must regard the action by which bone is at all periods of life removed, prior to the development of new

tissue, as an abnormal process, and also the corresponding changes which go on in the cementum clothing the roots of permanent teeth. It would appear rather, that wherever the necessity for the removal of osseous tissue arises, the structure capable of fulfilling the office is developed, and in a vast number of cases quite independently of abnormal action, and that the seat of the development may be in any vascular structure.

The observations at present at our disposal are not sufficiently numerous and varied to admit of the deduction of any general law, as regards the power by which absorption of one tissue by another is effected. But I think they point strongly to the idea, that a cell structure in an active state of development, is capable of appropriating or removing out of its way a matured tissue.

The eruption of the permanent teeth.—Attention has already been directed to the changes in the condition of the alveolar processes antecedent to the eruption of the temporary teeth. Very similar conditions prevail when the permanent organs are about to make their appearance through the gums. It has been shown that absorption of the alveolar margin of the sockets of the first teeth is not necessarily coincident with the removal of their roots, but that the opposite condition very commonly obtains; that absorption of the dental tissues may be accompanied by development of osseous structure. When, however, the permanent tooth is ready to emerge from its bony cell, absorption is again set up, and in this case the bone which lies over the crown of the growing tooth is attacked. The coronal portion of the crypt is enlarged, and the outer alveolar plate emarginated in the

manner which we have seen precedes the evolution of the temporary tooth. The aperture becomes enlarged until the crown of the tooth can readily pass through. The comparatively large size of the crown as compared with the neck or the root of a tooth, necessitates a breadth of socket, during the period both of development and of evolution, far greater than is required for the implantation of the fully-emerged organ. Hence a tooth at this stage of its progress can be readily moved from side to side by moderate pressure, and very slight mechanical obstruction will turn it either into or out of its normal position. The presence even of a small portion of the root of a temporary tooth will be sufficient to change the direction; and on the other hand, the action of the tongue on the lips will suffice to bring the out-growing organ into its natural position, if the impediment be removed during the period of active eruption. The condition to which I have alluded is shown in the enlarged alveolar apertures of the first permanent molar teeth in Fig. 35, and will be seen in connexion with other permanent teeth forming the subject of subsequent illustrations.

The provision for a tooth to take its proper place, displayed in the greatly widened socket at the period of eruption, would however be insufficient if the whole of the front teeth advanced towards their ultimate position simultaneously. It has been shown that the crowns, while within the jaws, are necessarily placed in an uneven line, and this irregularity would become permanent if all were to make their appearance through the gums at the same time. But, although the jaws at the age of five or six years do not afford sufficient space for the uniform arrangement of the crowns of the developing

teeth, yet there would be ample room for the roots of these teeth to be placed in an even line. It has been stated that the crowns of the forming teeth are inclined slightly outwards, and that the growth of the alveolar arch is principally confined to the free edges and the outer surface. Bone is added externally, while it is being removed from the inner surface of each crypt to allow space for the increasing tooth, at the same time that the tooth is moved bodily forward. If adult specimens in which the teeth and jaws are well formed, be examined, it will be found that growth in the direction indicated has been continued until the parts have arrived at maturity. In the adult the crowns of the front teeth are placed in advance of the base of the nose; in the child they are in a line vertical to it: and if we measure the ellipse formed by the anterior surface of the upper jaw in a horizontal line with the last-named point, extending on either side to the second bicuspids, and then apply the measure to the corresponding part in an adult, or in an edentulous old person, we shall find the result in each case very nearly similar. In tracing the permanent teeth as they are respectively protruded and take their position in the dental arch, it is desirable to bear the foregoing points in mind. In certain cases we shall find mischief arises from want of growth in the facial bones at the earlier periods of life, but in many instances the deviations from the normal position of the teeth and alveoli are independent of insufficient size of the bodies of the maxillæ; or in other words, cases in which the basal line has attained its usual extent, while the teeth are irregularly placed in an irregularly-formed arch.

It is necessary to draw a distinction between the bodies of

the maxillæ and the alveolar processes, as it will subsequently be shown that in cases of irregular dentition, the irregularity may depend upon a want of accordance between the general dimensions of the jaws and the determined size of the teeth; or the mal-arrangement may depend solely upon imperfect development, in respect to position, of the teeth and the alveoli.

In describing the evolution of the teeth individually, and the coincident conditions, the chronological order in which they usually appear will be followed.

The first permanent molar of the upper not uncommonly precedes by a few weeks the corresponding tooth of the lower jaw; but I do not know that, in respect to priority, any great uniformity prevails. The conditions presented by these teeth at the age of *six years and five months*, are shown in Fig. 35. In the upper jaw, the bone which lay over and protected the tooth at an earlier age, is entirely removed, not only from the coronal surface, but also to a great extent from the labial side of the crypt; and this has taken place prior to the tooth being raised above the general level of the alveolar margin. It is now, however, in a condition for rapid development of the fangs, and two or three months would have served to bring it to the surface of the gums. On removing one of the teeth from the upper jaw, the roots, although very short and imperfect, are seen to have their respective positions defined, the neck of the tooth being perfected. The enamel has attained its maximum amount, and is deficient only in density. At the age under consideration, the first molars occupy the posterior part of the alveolar arch, the second molar in the upper being confined to the back part of the tuberosity,

and in the lower jaw to an excavation in the base of the coronoid process.

In a specimen obtained from a female subject aged *seven years*, the first molars have gained the level of the temporary teeth, although the fangs are at present very short and truncated; each fang has its own well-defined socket, the depth of which is equal to the length of the developing root. If a tooth be extracted before decomposition has commenced, it will be found that the formative pulp is contained within the large and open cavity of the fang, projecting only in a very slight degree from the extremity. It looks as though it had been cut off on a level with the end of the root, so abrupt and flat is the termination of the soft tissue. Were it otherwise, pressure upon the masticating surface of the tooth would produce compression of the pulp, as the socket has not yet contracted to the dimensions of the tooth, and the septa of bone which eventually rise between the roots, are not sufficiently developed to take the pressure, and thus relieve the roots from being driven against the bottom of the socket.

In the accompanying figure (Fig. 38), the molar of the right is in advance of the corresponding tooth of the opposite side of the jaw. On the one side the tooth had appeared through the gum, on the other, the surface of the mucous membrane had not been pierced. The position of the second molar is indicated by the asterisk. In the specimen previously described, the first molars occupied the terminal portion of the alveolar arch; in the present case a small amount of space posterior to them is gained, and the second molars, which were placed at the back part of the tuberosity and directed backwards, are

now descending into the dental line, and are directed obliquely downwards and backwards.

In the specimens which have been described, the new teeth in their implanted portions are quite equal to the depth of the sockets, the bottoms of which reach in the upper jaw to the floor of the antrum, and in the lower maxilla to the in-

Fig. 38. [1]

ferior dental canal. This leaves no room for growth in the direction of the deeper parts. The increasing length of each tooth must therefore be accompanied by an increased depth of socket produced by addition of bone to the free margin of the alveolus.

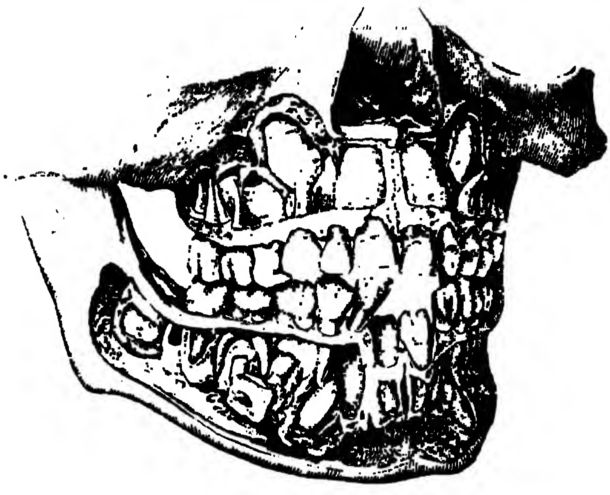
The development proceeds rapidly until the opposing teeth come in contact, when the antagonism becomes ad-

[1] Showing the condition of the alveolus of the first permanent molar at the time the tooth is advancing to the surface of the gum. The tooth on the right side is a little in advance of that on the left side of the mouth. * The crypt of the second permanent molar.

justed, a process which is rendered easy by the comparatively loose implantation of the teeth.

The teeth which usually succeed the first permanent molars in the order of emergence, are the central incisors of the lower jaw. After the temporary central incisors have been shed, absorption of the corresponding edges of the alveoli commences, and commonly carries away the outer plate to a considerable depth. The condition is shown in Fig. 39; in

Fig. 39. (1)



this case the whole of the bone which lay in front of the crowns of the new teeth has been absorbed. In other instances the waste may be rather more limited, but in all cases

(1) Shows the relative position of the two sets of teeth, and the absorption of the anterior plate of the alveoli of the lower central incisors antecedent to their emergence. In the upper jaw the roots of the temporary incisor have been removed, and absorption of the edge of the alveolus of the left central incisor has commenced. It will be seen that the depth of the alveoli at this point is equal to the length of the developing teeth.

the depth of the jaw becomes diminished at the points corresponding to the teeth, which are about to advance from their osseous crypts to the surface of the gums. The posterior alveolar plate, although diminished in height, usually suffers in a much less degree than the outer surface of the jaw, and consequently offers a less broken outline than that shown in the last figure. If the specimen under consideration be compared with an adult jaw from which the outer alveolar plate has been removed, it will be seen that the terminations of the two advancing incisors hold the position which the ends of the roots of the fully formed corresponding teeth occupy.

The conditions which have been described as pertaining to the eruption of the lower central incisors, will be found to accompany the evolution of the upper central teeth; the amount of bone removed by absorption varying with the position and size of the teeth. It is, however, by no means easy to obtain specimens of the age required to illustrate the changes attendant upon the eruption of the permanent teeth. The dealers do not appear to regard them as saleable, and they can be acquired from other sources only at uncertain intervals.

The subject (a female) from which the following figure has been taken, died at the age of seven years and eight months. The central incisors have emerged from the alveoli to the extent of about two-thirds of the length of their crowns, the right being a little in advance of its fellow tooth. The respective alveolar apertures are greatly enlarged, allowing the teeth to be moved either outwards or inwards.

In this instance, the jaw is rather contracted in size, and the new teeth, in the absence of the temporary laterals, have

their distal sides situated but a short distance from the canines, leaving insufficient space for the permanent lateral teeth, supposing the present position of the centrals to be

Fig. 10. (1)

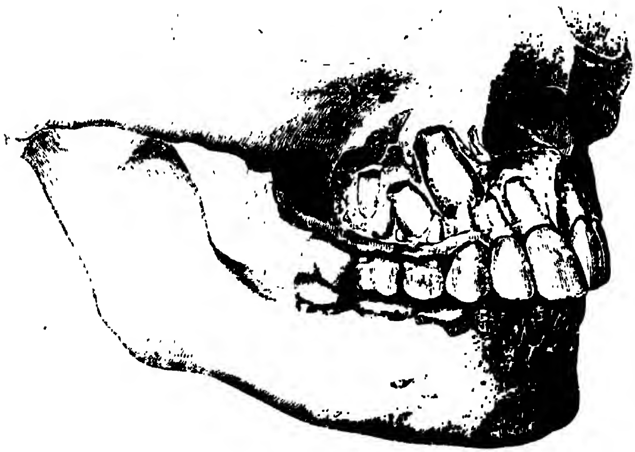
maintained. But the provision afforded for adjustment by the enlarged sockets, will allow the crowns of the teeth to take a more forward position, which, as they descend obliquely outwards, will be still further increased when the teeth have attained their full length. And thus the space, at present too limited for the normal arrangement of the neighbouring teeth, will eventually become sufficiently extended.

The phenomena which have been described as attending the eruption of the central incisor, are repeated when the lateral

(1) Upper jaw of a female subject seven years and eight months old, showing the central incisors taking their place in the alveolar arch. The right tooth is well placed, but the left is a little turned on its axis. The alveolus of each is larger than the contained tooth, affording space for the teeth to assume a normal position.

teeth are protruded. These are, however, subject to an influence as regards their position, from which the central incisors are exempt. The canines are at this period far advanced in development, and their large, rounded, mesial sides not unfrequently interfere with the direction of the roots of the lateral teeth, and thus tend to turn the crowns of the teeth out of their natural position—an evil which is usually remedied by the further descent of the canines towards the alveolar margin. The normal position of the incisors after falling into line, is shown in Fig. 41.

Fig. 41. (1)



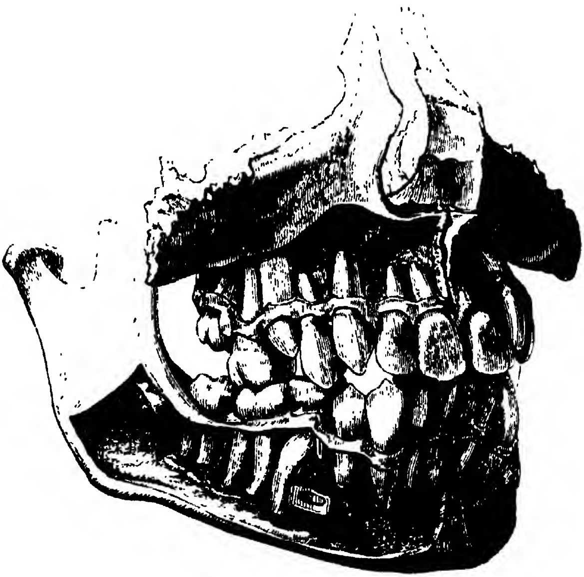
Taking what may be regarded as the normal order of eruption, the first bicuspids will succeed the lateral incisors. If Fig. 39 be examined, it may be seen that the convex distal side of the crown of the upper canine lies upon the mesial

(1) **Showing the permanent central and lateral incisors in their normal position in the dental arch, with the canine and bicuspids within the jaw.**

side of the neck of the first bicuspid, and necessitates the flattened or grooved surface which characterizes that part of the tooth, while the distal side of the tooth is similarly influenced (although in a less degree) by the second bicuspid.

After the first bicuspid has taken its position, the canines are the next to appear in the line of the erupted teeth. The appearances presented by the teeth in a favourable specimen are shown in Fig. 42.

Fig. 42. (1)



After the canines, the second bicuspids appear through the gums, and make up the full complement of those which have

(1) Showing the conditions of the permanent teeth after the eruption of the canines; in the upper jaw, the second bicuspid.

been preceded by temporary teeth. The preceding may be looked upon as the natural order in which the first permanent molars, and the teeth anterior to them, appear; but this order is frequently subverted, and in very many cases without entailing any evil consequences. It will, however, be convenient to consider all the deviations from that which is regarded as the normal order, under one general heading, after the evolution of the second permanent molar has been considered, and after the changes in the form and size of the jaws coincident with the eruption of the permanent teeth have been traced.

Between the age of twelve and thirteen years, the second permanent molars advance towards the surface of the gums, accompanied by alveolar changes similar to those which have been described in connexion with the emergence of other teeth. At this time the crypts for the third molars hold the positions which those for the second molars held when the first molars emerged from their bony cells, and occupied the terminal portion of the alveolar tract.

If the mouth be examined immediately after the eruption of the second molars, the dental arches will appear fully occupied. In the lower jaw, a tooth on either side will be placed close to the base of the coronoid processes, and in the upper maxilla at the extremities of the alveolar portion of the bone. But by the time the patient has reached the *sixteenth or twentieth year*, the jaws will have lengthened posteriorly, and to an extent sufficient for four new teeth to take their respective positions in the dental arches. Under favourable circumstances, the development and eruption of the wisdom teeth is but a repetition of those progressive changes

which have already been described in respect to the first and second molars, and therefore need not be dwelt upon. No doubt these teeth are seldom cut without greater inconvenience to the patient than the anterior molars, and the period of emergence, too, is less defined; but we have hitherto considered the eruption of the permanent teeth when the process has been perfectly normal, the deviations from which have yet to be considered.

The periods of eruption of the permanent teeth have in the foregoing pages been traced from preparations. But the subject has been examined statistically.

In 1837, Mr. Saunders published a monograph, entitled, "The Teeth a Test of Age." About this time, the miseries entailed by employing young children in factories were, not for the first time, forced upon the attention of the Legislature. The necessity of restricting the hours of labour and of establishing laws for defining the period at which children should be allowed to enter upon factory labour, was admitted. But a difficulty arose as to the principles upon which this period should be fixed. It was contended by some that a certain state of physical development should be taken as the standard, while others thought that the age would form a better criterion of the capabilities of enduring labour without injury. The statements of parents as respects the ages of their children could not be depended upon; hence it became necessary that some means should be found whereby the age of a child could be determined independently of the representations of interested parties. With this view, Mr. Saunders entered upon an inquiry respecting the relations of the eruption of the permanent teeth to the age of the individual. He

visited many of the large metropolitan schools, and selected for examination those children who had reached the ninth and the thirteenth year, and published the results in a series of tables, of which the following are characteristic examples:—

	Incisors.		Cuspid.	Bicuspid.		Molars.	
	Cent.	Lat.		Ant.	Post.	Ant.	Post.
Of 457 boys of nine years of age—							
20 had	4	4	...	...	...	4	...
77 had	4	3	...	...	...	4	...
91 had	4	2	...	...	...	4	...
5 had	4	1	...	...	...	4	...
34 had	4	...	...	...	...	4	...
20 had	3	3	...	...	...	4	...
10 had	3	...	...	...	...	4	...
Of 227 boys of thirteen years of age—							
104 had	4	4	4	4	4	4	4
57 had	4	4	3	4	4	4	3
29 had	4	4	3	4	3	4	2
33 had	4	4	3	4	2	4	1
4 had	4	4	2	4	1	4	...

Mr. Saunders sums up the results of his investigations in the following words:—

"Thus, then, it appears that of 708 children of nine years of age, 389 would have been pronounced, on an application of this test, to be near the completion of the ninth year; that is, they presented the full development for that age.

But on the principle already stated, that of reckoning the fourth tooth as present when the three are fully developed, a still larger majority would be obtained, and instead of 389, the proportion would be as follows: of 708 children, no less a number than 530 will be fully nine years of age. What, then, are the deviations in the remaining 178? They are the following:—126 would be pronounced eight years and six months, and the remaining 52 eight years of age, so that the extreme deviations are only twelve months, and these only in the inconsiderable proportion (when compared with the results obtained by other criteria) of 52 in 708.

"Again, of 338 children under thirteen years of age, no less than 294 might have been pronounced with confidence to be of that age. The remaining 44 would have been considered as follows: 36 in their thirteenth and eight near the completion of their twelfth year."

More recently Mr. S. Cartwright, jun., has published a Table which embraces a much more extended period, and gives results obtained from 3074 cases. After describing the order and the periods of eruption of the permanent teeth, he makes the following remark:

"These periods I find form a moderately fair average. I have particularised them for the sake of affording you some idea of the times of replacement of the various classes of teeth; but exceptions are so frequent, that it is not possible to give with accuracy the exact time for their change. These tables will show you the times of appearance of the teeth in the given number of cases—upwards of 3000—which I have collected and which have come under my notice."

The following is a reprint from his fourth lecture, published in the "British Journal of Dental Science," May, 1857:—

3074 cases.	Upper incisors.	Lower incisors.	Upper cuspids.	Lower cuspids.	Upper anterior bicuspids.	Lower anterior bicuspids.	Upper posterior bicuspids.	Lower posterior bicuspids.	Upper anterior molars.	Lower anterior molars.	Upper posterior molars.	Lower posterior molars.
Between the 5th and 6th birthdays: Out of 170 children	5	17	.	..	..	..	1	..	34	48	...	...
" 6th and 7th: Out of 340 children	52	207	..	...	3	1	2	4	182	199	...	...
" 7th and 8th: Out of 496 children	180	407	..	...	19	7	3	5	472	479	...	...
" 8th and 9th: Out of 530 children	459	524	8	7	85	38	16	12	524	524	...	...
" 9th and 10th: Out of 454 children	435	451	20	40	143	60	51	32	453	453	6	11
" 10th and 11th: Out of 322 children	318	321	48	98	199	104	110	69	322	322	18	26
" 11th and 12th: Out of 303 children	303	303	112	166	231	167	166	123	303	303	51	79
" 12th and 13th: Out of 203 children	203	203	136	159	175	149	144	102	203	203	103	118
" 13th and 14th: Out of 140 children	140	140	115	120	133	116	122	93	140	140	100	113
" 14th and 15th: Out of 86 children	86	86	79	83	86	86	79	77	86	86	78	79
" 15th and 16th: Out of 30 children	30	30	29	30	30	29	30	28	30	30	30	29

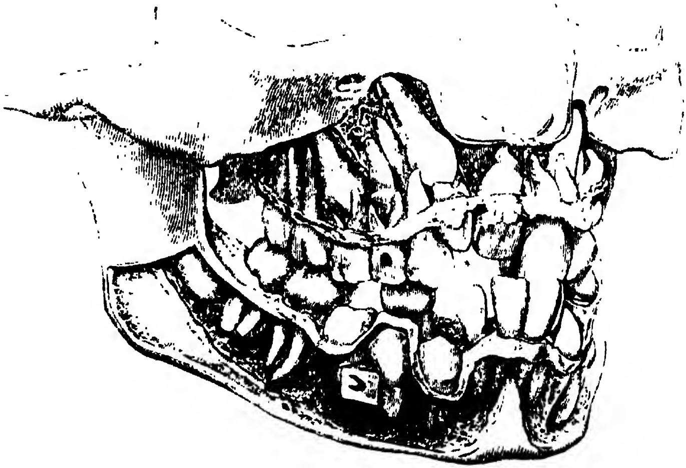
Before we enter upon the subject of irregularities in the development of the permanent teeth, and the various disturbing causes, it will be advantageous to give some further attention to the conditions under which the alveolar processes are formed, and to the laws which regulate the growth of the jaws.

Development of the alveolar processes in connexion with second dentition.—In the earlier pages, it was stated that the alveolar processes are formed after the dental papillæ are developed, and that at the time of birth they have risen up to the level of the developing teeth. Within two or three months they arch over and nearly enclose the teeth, thereby evincing a more rapid rate of growth than the teeth themselves. When the teeth are ready for eruption, the anterior wall of each alveolus is absorbed to the extent of about half its whole depth. The teeth emerge, and the alveolar processes again commence to grow; but not as in the former cases, more rapidly than the teeth. They now keep pace with the teeth. At the time the development of the several teeth is commenced, the papillæ are placed at the ultimate depth in the jaws. They do not grow into, but up from the maxillæ, and the alveoli grow with them. At the period of eruption the lower end of the truncated and unfinished root reaches to the bottom of the socket, the position of which, as regards depth, is not changed with the gradual lengthening of the root of the tooth. After emergence, the depth of the alveolus is equal to the length of the root of the inclosed tooth, the subsequent growth of the root at its base being equalled by the development of the alveolus at its free edge.

When the permanent teeth are ready to emerge, the process of absorption is again called into requisition, and the

labial wall of each alveolus is, in the anterior part of the jaws, removed, the loss of bone being extended to a point corresponding to the neck of the emerging tooth. This condition is shown in Figs. 32 and 39; but the accompanying illus-

Fig. 43. (1)

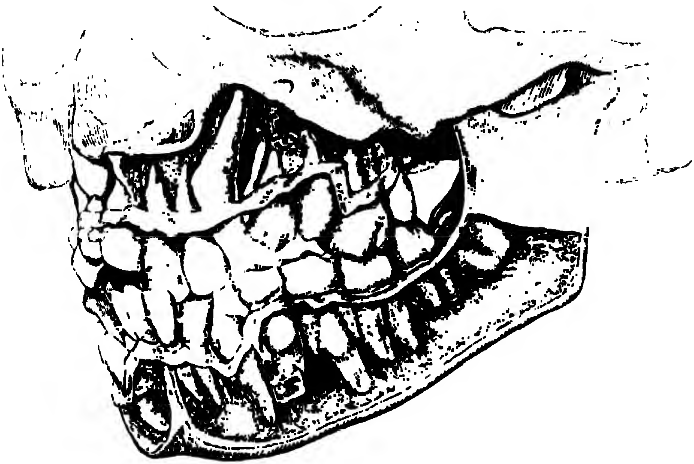


trations exhibit in a remarkable manner the dependency of alveolar on dental development. The dentition is in many respects irregular; but the point to which I would draw

(1) The upper and lower jaws of a subject about fourteen years of age; showing the relations of the alveolar processes to the teeth. In the upper jaw the temporary canine and the first and second molars are retained. *A supernumerary tooth has taken the place of the permanent lateral incisor, the lateral being forced backward towards the palate. The central incisor has been obstructed in its descent, and the root consequently curved. The permanent canine is far advanced in its development, but its descent is obstructed by the supernumerary tooth and the lateral incisor. In the lower jaw the first temporary molar has been retained, and raised to a higher level than usual, and with it the alveolus.

attention is the extremely broken line described by the alveolar margin, both in the upper and lower jaws. It may be

Fig. 44. (1)



seen that the terminal edge of each socket corresponds with the neck of the contained tooth, however irregularly the latter may be placed with respect to its fellows, exception of course being made to those teeth which have not yet passed through the gum. On the right side of the lower jaw, the first temporary molar is retained; and on the left, the second temporary molar is present. In each case the tooth and its alveolus is

(1) View of the left side of the specimen figured No. 43. In the upper jaw, the irregular line described by the alveolar margin is shown in connexion with the permanent teeth. In the lower jaw, the first and second temporary molars are retained, and both the teeth and their alveoli are raised above the level of the permanent teeth and their sockets. Both this and the preceding figure illustrate irregularities in the position of the permanent teeth, and will be referred to in connexion with the subject of irregularity.

raised to a higher level than is usually attained by the temporary teeth, and higher than the adjoining first permanent molars and their sockets. This elevating process has no doubt been effected after the tooth itself had been matured, and shows in a remarkable manner the relation of alveolar development to the changes of position in the teeth. It is not uncommon to find temporary molars present, even in patients of advanced age. I occasionally see a gentleman, over fifty years of age, in whose lower jaw the second temporary molars have been retained. They range with the adjoining teeth, and perform their part in mastication. The teeth generally are of the usual size, and the jaw and alveolar processes maintain the usual depth. In this case the temporary teeth and their alveoli must, at the period of second dentition, have been raised to the level of the adjoining parts of the dental arch. Other instances present themselves in which the persistent temporary teeth do not gain the general level. The cause is, however, usually very apparent: the contiguous teeth hang over, and as it were hold down the depressed tooth; and here again the socket corresponds to the level of the neck of the tooth. There is no disposition on the part of the bone at this point to grow up to the general line of the alveolar processes, independently of the tooth to which it gives implantation. In the one case we have a tooth raised above, and in the other held down to, the normal height of a temporary tooth; and in each the alveolar development has strictly conformed to the position of the tooth.

The appreciation of the foregoing conditions will be found of great practical value in respect to the treatment of irregularities in the position of the permanent teeth. Diseased

action in the structures may, however, modify the relations of the one part to the other. I have seen a case in which the alveolar processes were enormously thickened, and so raised that the teeth lay in grooves; and instances are not very uncommon in which development of the osseous tissue is arrested. But the results of normal action only have as yet been considered. The consequences entailed by disease upon the permanent teeth and their sockets, will be treated in a future page.

Growth of the maxillæ during second dentition.—In pursuing this inquiry, the natural variation in absolute size and in the minor details of form, which the jaws, in common with other parts of the body, present in different individuals, must be kept in view. It will be desirable, therefore, in repeating these observations, to select for examination specimens which present the average condition of the parts.

On comparing the jaws of a child in whom the first permanent molars are advancing towards the surface, with the maxillæ in which the wisdom teeth have taken their ultimate position, we are at once struck with the great difference in size, not only of the teeth, but of the jaws themselves; and it seems at first sight very difficult to explain how the smaller can assume the characters of the older specimen, without having recourse to the undefined idea of general expansion by interstitial growth throughout the whole substance of the bones.

It has been shown how the alveolar portions grow up, are partly removed, and again grow up; how they are from time to time moulded to the required forms; and it will not be difficult to point out how the other parts of the jaw are, by

the recurrence of similar actions, gradually advanced until the adult forms are attained.

In the preceding pages, certain parts were referred to as being less liable to change of position during the period of growth than other portions of the maxillæ, and to these attention must be again directed.

At p. 20, the position of the tubercles for the attachment of the *genio-hyo-glossus* and *genio-hyoideus* were referred to in a nine-months' subject, as parts suffering little change of position during the period of growth. In the specimen there described, it is found that if the jaw be placed upon a flat surface from which to make measurements, the distance from the upper pair of tubercles to the level of the lower border does not exceed $\frac{1}{12}$th of an inch. In a jaw from a subject seven years old, the corresponding part measured $\frac{6}{12}$ths of an inch; in an example of fourteen years, the distance had not increased. In another specimen, aged twenty-one years, the $\frac{1}{24}$th only had been added. But if, instead of measuring from the foregoing points, the distance from the upper tubercles to the alveolar margin be taken, the following results will be obtained:—In the nine-months' subject, $\frac{4}{12}$ths; in the seven years', $\frac{8}{12}$ths; in the fourteen-years', $\frac{10}{12}$ths; and in the twenty-one years', $\frac{10}{12}$ths of an inch.

These dimensions are taken from well-formed jaws of medium size, and may be regarded as typical examples of the progressive changes in the parts measured during the periods embraced by the several specimens. It is thus shown that, ordinarily, the depth of the jaws below the upper *spinæ mentales* is doubled between the ages of nine months and seven years, the amount gained being $\frac{3}{12}$ths of an inch; and

that after the seventh year, but little change takes place at this point in respect to the mere depth; while the parts above the *spinæ mentales* during the same period increase from $\frac{4}{12}$ths to $\frac{10}{12}$ths of an inch, the maximum height being attained by the fourteenth year. In the great majority of specimens a small foramen is situated in the median line, immediately above the upper pair of tubercles, and when present this may be selected as a point from which to take the foregoing dimensions. Unfortunately it is sometimes wanting, or is represented by a similar aperture below the spinæ mentales. In a series of jaws taken from very old subjects, in whom the teeth had been lost and the alveolar processes had been absorbed, the foramen holds its usual position. If these specimens are subjected to measurement, we find that this aperture is within from the $\frac{1}{12}$th to $\frac{3}{12}$ths of an inch of the alveolar margin, showing a loss in the oldest jaw of $\frac{9}{12}$ths, while it is separated from the lower border of the jaw by $\frac{6}{12}$ths of an inch, the loss in this direction being inappreciable.

If a horizontal line be drawn intersecting the upper pair of tubercles and the mental foramina, or if a series of jaws of different ages be sawn through in the line indicated, it will be seen that but comparatively little change, either of form or of dimension, has taken place after the period when the two halves of the jaws became anchylosed, excepting such as may have resulted from the much greater thickness and solidity which have been acquired in the part cut through.

If the mental foramen be taken as a centre from which to measure the depth of the jaw, very different results will be obtained as respects the relative rates of increase above and below that point. Thus in the nine months' specimen we

have $\frac{2\cdot5}{12}$ths below and $\frac{3\cdot5}{12}$ths above; in the seven years' specimen, $\frac{4}{12}$ths below and $\frac{6}{12}$ths above; in the fourteen years', $\frac{6}{12}$ths below and $\frac{6}{12}$ths above; and in the twenty-one years', $\frac{7}{12}$ths below and $\frac{7}{12}$ths above.

These dimensions show either that the jaws have increased in nearly an equal ratio above and below the opening, or that the position of the foramen has been changed during growth. If the outer surface of bone be removed, so as to expose the inferior dental canal throughout its length, in a series of specimens of progressive ages, the manner in which the change of position of the mental foramen has been effected will be seen. In the nine months' subject the opening is upon a level with the course of the canal, but with the increase of bone upon the surface, during growth, the aperture becomes gradually raised to a higher level, not however by the direction of the canal itself being altered, but by an increased length corresponding to the increased thickness of the outer portion of the bone. The canal in the recently formed bone is directed upwards and outwards, its position as regards the previously formed part being rectangular. The angle so produced corresponds in its position to the foramen in the young subject. If the examination be extended to aged edentulous jaws, it will be found that a large portion of bone has been removed from the surface, and that the terminal portion of the dental canal has been consequently shortened, and the foramen brought nearer to the lower border of the jaw.

With the exception of additions to either end during the period of growth, and the consequent alterations of the apertures, there does not appear to be any evidence in favour of the supposition that the position of the canal is changed,

either at the epoch of second dentition, or indeed at any other time.

In the nine months' subject, when the anterior teeth are about to be cut, the canal is nearly straight from end to end, the whole length corresponding to that portion which in the adult lies under the bicuspids and first permanent molar, and forms scarcely more than one-third of its entire length. The straightness of the anterior third is permanently preserved in all the specimens I have examined. The middle third is slightly curved upwards, and the posterior portion is still more curved, and if prolonged, would pass through or immediately in front of the articular process. The course of this posterior third traverses the ascending ramus of the adult jaw rather obliquely, and in the great majority of cases corresponds with the direction of the condyle rather than that of the ramus. These points have been entered upon with some degree of minuteness, in consequence of their affording evidence as to the manner in which the jaw becomes lengthened to so great an extent by additions at its posterior portions.

In tracing the growth of the jaw backwards, we may take the inferior dental canal as marking pretty accurately the line of growth followed by the condyle, and the external oblique line as that which has been followed by the base of the coronoid process. For the sake of facilitating description, it may be assumed that the backward growth takes place at three points—in the sub-articular cartilage of the condyle, in the periosteum investing the coronoid process, and in that investing the angle.

The condyle stands with its long axis directed nearly transversely across the ramus, the one extremity lying nearly on

a plane with the outer surface of the bone, while the other overhangs to a considerable extent the inner surface of the ramus. Now, if we take a thin vertical section, suitable for microscopic examination, from a perfectly fresh young jaw, it will be seen that new bone is developing in the temporary sub-articular cartilage—not, however, in the linear manner usual in the temporary cartilage of long bones, but by the extension of ossification among small groups of cells. As the action extends throughout the articular extremity, the bone so produced would, if permanently retained, assume the form of a broad process, marking the course through which growth proceeded. On the outer surface we frequently can discern a slight ridge, extending a short distance from the head of the bone; but if the prominence were preserved on the inner surface, the inferior dental artery and nerve would be turned from its course towards the canal. Hence the hard tissue, although produced, is at this point speedily removed, and in the place of a ridge extending from the articular process downwards, we have a concavity immediately below the articulation, and along it the vessels and nerves pass before entering the bone. A section taken from this part will show that the newly-formed bone has been removed by absorption.

The progressive growth of the coronoid process is effected in the usual manner of sub-periosteal development—that is, by the ossification of cells and connective blastema; and here, again, the modelling process effected by the supervention of absorption is called into requisition. If all the bone which is developed were retained, we should have a breadth of ramus extending forward over half the alveolar margin. If a transverse section be taken from the base of the ramus of a growing

jaw, it will be found that indications of absorption are presented at the anterior edge; and at the point corresponding to the posterior border of the jaw, evidences of osseous development are present.

In examining a series of suitable preparations, it may be seen that the crypts for the permanent molar teeth are in the first instance formed internal to the ridge of bone which forms externally the base of the coronoid, and that this ridge is continuous with the external oblique line of the jaw. Absorption in this neighbourhood appears to stop short before reaching the absolute base, and leaves a trace of the ridge alluded to: the trace constituting the oblique line within which the alveoli of the molar teeth grow up.

The manner in which additions are made to the posterior border of the jaw, has been described in connexion with the growth of the jaws of very young subjects. During the period of youth the process is continued, and as the subject approaches manhood, the angle becomes fully pronounced. At the same time, the mental prominence and the points for the insertion of muscles attain their permanent characters. In each case the increased size is produced by sub-periosteal development upon the pre-existing bone. The development of the jaw may, in some respects, be compared to modelling. Portions of new tissue are laid upon that already formed, and reduced to the fitting size and shape, and again renewed at such points as the attainment of the ultimate form of the part may require.

Still, even during manhood, the maintenance of the form of the jaw is dependent to a great extent upon the teeth. When the organs of mastication are lost, the whole of the alveolar processes are by degrees removed, the process of absorption being

arrested only at those points where muscles are inserted; neither is the waste limited to the alveolar margin. Both the outer and inner surfaces of the bone are reduced, and even the interior becomes more porous than during the period when the teeth were present. The spinæ mentales, however, retain nearly their full size, although the angle of the jaw about which the masseter muscle is inserted, suffers considerable loss—not however until that muscle is thrown partly out of use by the loss of the teeth, and consequently of the capability of mastication. If two jaws be taken, the one full of teeth, the other from an old edentulous subject, and in each the dental canal be exposed throughout its length, we may then, by the use of a file, taking the canal as our guide in removing the bone, reduce the younger to the form of the older jaw. In the one case we have a jaw for the implantation of teeth, and for the insertion of powerful muscles for bringing the teeth into effective use, in addition to affording attachment for muscles connected with the organs of speech and deglutition; and in the other, the jaw is subservient only to the latter purposes.

We have hitherto spoken of the lower jaw, which, from its slight connexion with the other bones of the face, can be studied in its progressive changes of form and size more readily than the superior maxilla. But if crania of various ages, extending from seven to twenty-one years, be carefully examined, the difference presented by the upper jaw at the several periods, and the manner in which these differences have been produced, may be recognised. Mr. Hilton, in his monograph on the development of certain portions of the cranium, makes the following statement:—

"The sphenoid bone forms the centre around which all the other bones, both of the cranium and face, are developed. It is truly and literally indeed a wedge, as its name implies; and thus impacted or wedged in amongst all the other cranial and facial bones, its progressive development spreading its different processes out in all directions, plays a most important part; not only in determining the adult configuration of the skull, but in adapting the final conformation of the organs of the face to the increasing perfection of their associated functions. The mouth, nose, orbits, and pharynx, are all more or less directly influenced, and contemporaneously rendered more perfect in form by the complete development of this bone.

"The primary idea, or primary intention of the development of the sphenoid, seems chiefly with reference to the masticatory function; but in the changes that it produces in the direction of the cranial and facial bones, it may not inaptly be compared to the scaphoid bones of the carpus and tarsus; for in its growth and final development it effects for the cranium and face precisely the same object that these bones effect for the hand and foot.

"Like these bones, then, the growth and completion of the sphenoid, in spreading out the cranium, and in enlarging the cavities of the organs belonging to the face, supplies the deficiency of the muscular tension which in other parts of the body has so large a share in determining the final or perfect forms of the bones."*

Of the different parts of the sphenoid bone, those which

* Notes on some of the Developmental and Functional Relations of certain Bones of the Cranium. Selected by F. W. Pavy, M.D., from Lectures on Anatomy by John Hilton, F.R.S. 1855.

undergo the greatest change during the period under consideration, as regards size, and which are also the most directly connected with the present inquiry, are the pterygoid plates. These parts increase to the extent of one-third of their ultimate length between the age of seven and twenty-one years. In a specimen of seven years, the anterior surface of the pterygoid process is separated from the first permanent molar by a distance scarcely exceeding a quarter of an inch, and the nascent second molar lies in the tuberosity, in great part external to the sphenoidal processes. The space, at present so inconsiderable, has, before the adult form is acquired, to be increased fully two-thirds, accompanied by an increased length of the pterygoid plates, the general direction of which remains unchanged. The general principles which have been pointed out as pertaining to the development of the lower jaw, may be applied to those facial bones which are connected with the masticatory apparatus. The tuberosity is to the upper what the base of the coronoid process is to the lower jaw. From this point the alveolar line is lengthened. In the specimen last mentioned, the second molar is buried high up in the tuberosity. Soon after the expiration of the twelfth year, the distance between the pterygoid process and the first molar will have increased sufficiently to allow the second molar to take its place in the dental line, and by the expiration of the twentieth year the third molar is usually found in its normal position. Up to this period, the facial bones are connected to each other and to the bones of the cranium by sutures only; and in the soft tissue within these, development of bone takes place.

The maxillary bones, while their processes are increased in

length, are moved bodily forward, the rate of growth keeping pace with the increase at the tuberosity. Coincident with development, the modelling of certain parts by superficial absorption is carried on. By this process, the anterior surface of the lower border of the malar process is removed, and thus thrown backward. In the seven-years' specimen, it lies immediately above the anterior third of the first molar; at twenty-one it holds a similar position with respect to the second molar, thus showing a recedence equal to the width of one tooth.

As respects the changes of form and position which the glenoid cavity undergoes during growth, but little need be said. Here we have articular cartilage, beneath which the required amount of bone is slowly developed in the same manner as in the sub-articular cartilage of the lower jaw.

The growth of the alveolar process need not be again referred to.

After the teeth are lost, the upper jaw undergoes great change both in size and in form, not, however, from what is called interstitial absorption, but simply from progressive superficial absorption. The alveolar processes are gradually lost, and the whole bone is reduced in thickness. The pterygoid plates of the sphenoid bone become greatly diminished in size and strength, while the glenoid cavity loses its strongly pronounced margin, and hence becomes flattened.

Certain forms of irregularity in the conformation of the jaws being closely connected with deviation from the normal arrangement of the teeth, will be considered in connexion with the latter subject.

Irregularity of the permanent teeth.—Hitherto the descrip-

tion of the permanent teeth has been confined to their evolution, when those general laws which regulate the time of appearance, the position, the form of the individual members, and the implantation of the whole set, have operated without interruption.

The deviations from the normal conditions as respects arrangement, number, form, and the period of eruption, have yet to be considered before we come to the conclusion of that division of the subject which has been placed under the general head of teething. The divisions of this subject will be treated in the order in which they have been enumerated.

Irregularity in the position of the permanent teeth, irrespective of the number involved, admits of division into two distinct groups. 1st. Irregularity in the position of the crowns, while the roots at their terminal points hold the usual place. 2nd. Irregularity both in the position of the crowns and roots. The former usually admit of treatment which does not necessarily involve the loss of either the misplaced or a neighbouring tooth; while the latter cases do not admit remedy, excepting by removal of the malplaced organs.

Those examples which fall within the first division will be first considered.

The front teeth of the upper jaw, including the canines, may deviate from the usual position either by projecting forward or retreating backward. In the former deformity, the prominence is sometimes sufficient to prevent the lips from closing; hence the teeth are constantly exposed, even when the mouth is shut. The lower lip, instead of lying over the edges of the teeth, passes behind them, while the

lower teeth meet the gum posterior to the necks of the upper teeth. In searching for the cause of this unsightly form of irregularity, we must examine the condition of both the upper and lower jaws, and also the state of antagonism of the upper and lower teeth.

The deformity may result from excessive development of the alveolar processes of the anterior part of the upper jaw, but more commonly we shall find that the molar teeth are unusually short, thereby allowing the incisor teeth of the lower to press unduly upon the inclined lingual surfaces of the teeth of the upper jaw. The upper teeth, yielding to the pressure, are forced outward, and are retained in the malposition by the teeth which have led to the displacement. If, in cases resulting from the latter cause, the inquiry be extended to the condition of the lower jaw, it will be found that with the short molar teeth we have a short alveolar range and short rectangular ramus. This conformation is probably the primary cause of the mischief. Supposing the line of growth in the ramus to have become nearly rectangular as regards the body of the jaw, prior to the development of the wisdom teeth, and the amount of growth in the vertical direction to have been deficient, the molar teeth would be limited in height by the antagonism of the corresponding teeth of the upper jaw. That the length of the molar teeth is influenced by the growth and position of the ramus, a case at present under my treatment satisfactorily demonstrates. In this instance the ramus has preserved the obliquity characteristic of childhood, and occasions the permanent separation of the upper and lower front teeth when the mouth is closed. The patient is upwards of fifteen, and the usual

number of teeth are present; but the second permanent molars are the only teeth that come in contact, and these scarcely project above the level of the gums. Here the ramus is sufficient in actual length, but the obliquity renders its length unavailable for the vertical development of the molar teeth. If, then, we have a rectangular ramus of diminished length, with short grinding teeth coincident with well-developed incisors, it is not difficult to see that the upper will be driven outwards by the lower front teeth.

The condition under consideration may also arise from the tardy eruption of the molar teeth leaving the incisors to act for a time upon each other, as they do when from any cause the back teeth are lost. Then again, the incisors of the lower jaw may attain an unusual height, or they may project in an unusual degree, and produce the mischief. Or the result may be consequent upon a regular linear arrangement of large teeth in a jaw having a small alveolar base, in which case the teeth prior to their eruption will assume an unusual anterior obliquity.

But whatever the cause, the treatment of this form of irregularity is apt to be very troublesome. It is not difficult to reduce the teeth to a proper position, but it is very difficult to keep them there. In a case which came under my treatment four years since, the upper teeth projected outwards, so that it required a great effort to get the upper lip over them, and when the mouth was closed the finger could be laid between the lingual surface of the upper and labial surface of the lower teeth. The habitual position of the under lip was behind the upper front teeth—a habit which in itself no doubt tended to increase the amount of deformity. The

arrangement of the teeth as respects each other, was perfectly uniform and without intervening spaces, while the base of the jaw was normal in size. It was therefore quite obvious that before the teeth could be pressed backward, space must be provided to allow of their movement in that direction. In order to effect this, the two posterior bicuspids were removed; a metal plate was then fitted to the labial surface of the projecting teeth as far on either side as the canine, and was extended inwards below the edges of the teeth in such a manner as to prevent the under lip from passing behind the upper teeth. A strong band of vulcanized caoutchouc was connected with the plate, and passed round the back of the head. By means of this apparatus the teeth were in the course of six weeks pressed into a very good position. The lips could be closed in the usual manner, and the mouth when seen in profile had lost its objectionable prominence. The patient on leaving for the country was directed to wear the apparatus during the night for six months. After the lapse of eighteen months she returned to town with the mouth just as prominent as it had been before treatment. On inquiry I found that she wore the plate for one month only, the elastic bands had then given way, and the precautionary measures had from that time been neglected. In the interval the wisdom teeth of the upper jaw had been cut, and they seemed to have exercised some influence in forcing the teeth into the forward position. But some other cause than this was also in operation, as the teeth, although prominent, were not now, as formerly, in close lateral contact. The wisdom teeth, from their position, being perfectly useless, were removed, and the treatment already described was re-

newed, and with the former success. The teeth have now settled down into a position intermediate between that which they held before they were subjected to treatment, and that to which they were reduced by the use of the plate.

The foregoing case may, I think, be regarded as presenting typical characters, and may therefore be dwelt upon for the purpose of elucidating some of the general features connected with irregularities before we advance further. Possibly the front teeth, while within the alveolar crypts, assumed an unusual obliquity of position, and thus grew outwards independently of any influence exerted by the antagonistic teeth. But whatever may have been the cause of malposition, the growth of the teeth was accompanied by the development of strongly-pronounced alveoli, corresponding in direction with that of the teeth. In cases such as that described, it is sufficiently obvious that before the direction of the teeth can be permanently changed, the direction of the sockets must also be altered; a considerable portion of the existing alveolar processes must be removed, and new bone for the repair or rebuilding of the sockets be produced. It may not, however, be necessary that the position of the bottom of the sockets should be changed, although the margins require to be reduced to a semicircle of much smaller radius. Now we know that moderate pressure, constantly maintained upon bone, will lead to its absorption; if therefore the crowns of the teeth be steadily and constantly pressed upon, that portion of the socket which receives the pressure will gradually disappear. The immediate result will be an enlargement of the socket in which the tooth will for the time move freely, in other words, it will become loose. This condition, if long

continued, would lead to the early loss of the tooth; hence to ensure success in our operations for readjustment, new bone must be produced in those parts of the socket from which and towards which the root of the tooth has moved. The fact of a tooth becoming loose under undue pressure, shows that the absorption may proceed more rapidly than development of bone.

The recognition of this fact, which may be assumed as a constant condition, suggests a very important question—viz., at what rate in respect to time can new alveolar bone be developed, when the removal of the pre-existing tissue has been induced by pressure? The determination of this point will also assist in determining the degree of pressure which can be used most advantageously, and the length of time it will be necessary to employ mechanical means for retaining the tooth in the position into which it has been forced. If an extreme case be taken for treatment, the extent of change produced, supposing the treatment to be permanently successful, will amount to the destruction of a considerable portion of the existing, and the production of new alveoli.

In the absence of well-established facts gained from dissections, in respect to the period required either for the re-development of alveoli, or the degree to which restoration is carried, we are thrown upon the general results obtained in the treatment of cases, and upon the conditions which are found to obtain in the development of alveoli during the eruptive period of dentition. It has been shown that the socket grows up cotemporaneously with the gradual development of the tooth, but in this case the process of growth is extended over many months, and the results obtained in the reduc-

tion of irregularities do not tend to show that the alveolar reparation is more rapid than the original alveolar development.

If, for example, slightly projecting teeth are by means of pressure brought rapidly into the proper line, and are then left without mechanical restraint, they will speedily return to their former place, and become firmly fixed in their sockets in a much shorter time than they would have done if retained in the newly-acquired position. This circumstance would seem to indicate that in moving the teeth the sockets had been stretched or bent rather than absorbed; but there are many cases in which the assumption that the bone yields by its elasticity in the direction of the pressure applied to the teeth, does not offer a satisfactory explanation; and I am disposed to think that even in the cases where this explanation would at first sight appear tenable, the phenomena may be attributed to other causes.

The immediate consequence of continued pressure upon the crown of a tooth, is irritation and thickening of the peridental membrane; and this results in the tooth being raised in its socket to an amount equal to the increased thickness of the membrane.

The root of the tooth, from its more or less conical form, acquires, when raised in the socket, an increased capability of motion, without the alveolus itself becoming enlarged. Instances in which these conditions are produced by disease are of daily occurrence. A tooth is attacked with pain, and in a few hours the patient discovers that the tooth has become too long, and feels slightly loose. The increased capability of motion is recognised if the tooth be grasped between the thumb

and fingers; but it will at the same time be found, that although it readily yields within certain limits to pressure, yet that the movement is abruptly stopped when the side of the root comes in contact with either wall of the socket. A piece of india-rubber compressed between two teeth will, in the course of a few hours, force them apart, each tooth becoming tender to the touch and slightly loose; but although the teeth, on the removal of the caoutchouc, for a time stand apart, they will speedily resume their former positions, become firm, and free from tenderness. In this case, it can scarcely be assumed that the socket became enlarged by absorption, and again contracted by deposition, although the separation was greater in amount than could be accounted for on the supposition that the peridental membrane only yielded to the pressure; but the difficulty of explanation disappears on finding that the teeth are slightly raised in the sockets. In these instances we have examples of the manner in which the position of a tooth may, under pressure, become changed, without the socket undergoing any enlargement. In the treatment of cases, we find that within the first two days the out-standing teeth show most satisfactory results, and we are apt to conclude that the difficulty will be readily overcome; but in subsequent examinations we fail to recognise a corresponding amount of progress. The involved soft tissues readily yield, but until removed or weakened by absorption, the bone of the sockets resists the further movement of the teeth. The rate at which its removal can be safely induced is not, I think, satisfactorily ascertained. That we can induce its absorption, numerous examples prove; but in order to bring about the result, it is necessary that the pressure should be uniform in

degree, and uninterrupted. Destructive inflammation will be set up if the pressure be too great, and if it be too slight the teeth will not move, or the movement will be so slow that both the patient and practitioner become wearied before a successful result has been gained. A certain amount of irritation in the socket is a necessary attendant upon the treatment, otherwise absorption of the socket would not be induced. Other conditions being the same, the age of the patient will influence the results. The younger the patient, the more readily can the teeth be moved; the older, the more difficult will the operation become.

Supposing the irregular teeth to have been reduced to a proper position, and that the movement of them has been attended with a certain amount of destruction of the existing socket, we have then to inquire whether the lost parts will be fully replaced, and if so, the length of time required for the formation of the new bone. It is not probable that a series of preparations, illustrating the condition of the parts at different stages of treatment, will be obtained; we must therefore be content with less positive information than such a series would furnish, and avail ourselves of such facts as can be gathered from those cases in which teeth have been forced from their former position by a loss of proper antagonism. The dissecting-room will furnish examples of this character, and in them we shall find that the shifted teeth have a less perfect implantation than those which have been undisturbed. The sockets will not rise to the level of those of the other teeth; from which it may be inferred that the loss of the displaced teeth will be hastened. Whether the same conditions obtain in teeth which have in early life been intentionally

moved, observations directed to individual cases over very many years can alone determine. But supposing they do, we must put against the disadvantage the fact that the labial walls of the sockets of outstanding teeth are very commonly deficient in strength, or imperfect, and that teeth so placed are liable to become loose prematurely.

Admitting, then, that sockets partly removed under treatment will be restored, the question arises as to the time which will be occupied in the restoration,—in other words, how long it will be necessary to hold the teeth in the newly-acquired situation? If unrestrained by mechanical means, and uninfluenced by antagonistic teeth, the old position will soon be regained, and the teeth will become firmly fixed in a much shorter time than they would do in the acquired position. It would appear as if there were a natural law tending towards the maintenance of a conformation when once assumed, although an irregular one, and which calls into action the reproduction of a lost part more rapidly in the place in which a tooth has been moved from, than in that into which it has been moved.

We constantly hear of and see cases in which outstanding front teeth have been reduced to regularity, and have subsequently regained the objectionable position, notwithstanding the assurances which have been held out that such untoward results are consequent upon want of proper management on the part of the practitioner. There is, perhaps, no point in the whole field of dental surgery that yields a finer harvest to the charlatan than that afforded by the treatment of irregular teeth. The patients are necessarily young people who have not passed from the care of their parents. There is a great

desire on the part of the latter that the teeth should be good-looking, or at least not ill-looking; at the same time, there is great unwillingness, both with the patient and the parent, that the treatment should be extended over a long period of time. The presence in the mouth of a mechanical apparatus pressing upon the teeth interferes with the comfort of the young patient, and the frequent attendance at the house of the dentist encroaches upon the hours allotted for study. Both circumstances render prolonged treatment irksome, impatience is shown, the instructions are neglected, and, as a natural consequence, the results fall short of those which might have been obtained had the treatment been consistent. I believe it is in accordance with the experience of those who have devoted their attention to the treatment of irregularities, that where the front teeth have been brought in by mechanical means, and where mechanical means are required to hold them in place until they become permanently fixed, the treatment must be continued for twelve months. It may not be necessary that the apparatus should be constantly worn for the whole period, but it cannot be wholly thrown aside. Towards the latter part of the time, it may be worn occasionally only; but even after the lapse of twelve months, should the teeth show any indication of movement from the desired position, mechanical restraint must be resumed.

The foregoing remarks apply generally, but each case will present its own peculiar characteristics, and the treatment must be varied to meet them. The age of the patient, the state of health, the degree of susceptibility to irritation and pain, the number and condition of teeth present, the size of the teeth themselves, the size and form of the base of the

alveolar portion of the jaw, and the configuration of the same part in the parents—all these points must be taken into consideration before a course of treatment is determined on.

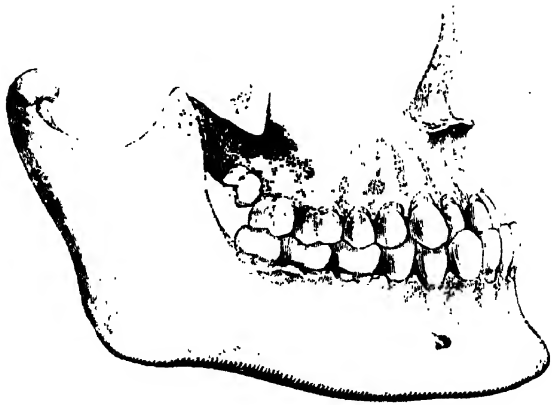
Reverting to the case related for the purpose of introducing a statement of those conditions which prevail more or less in all cases of malposition of the teeth, it may be observed that other methods than that adopted might have been pursued for bringing inwards the projecting teeth. Thus, a plate either of ivory or of metal might have been fitted to the hard palate and to the necks of the molar teeth, and to this the front teeth might have been tied, either with silk or caoutchouc ligatures; or a metal plate might have been fitted to the palate, and extended to the labial surfaces of the molar teeth, and on either side attachments for a band of india-rubber stretched over the labial surfaces of the front teeth might have been made. The apparatus adopted, however, possessed an advantage over these; it prevented the under lip from exercising an antagonistic influence, while it was simple in construction, and readily applied.

An opposite form of displacement to that which has been described is far from uncommon. The anterior teeth, instead of standing out far in front of those of the lower jaw when the mouth is closed, are directed inwards, and pass behind them. The patient is said to be under-hung. The upper lip is generally short and retreating, while the lower lip and chin hold an unusually forward position.

If the coincident conditions of the jaws be examined, it will be found either that the alveolar ridge of the upper maxilla is unusually small, as shown in the accompanying

figure, or that the lower jaw has departed from the normal form. In the specimen from which the illustration is taken,

Fig 45. (1)



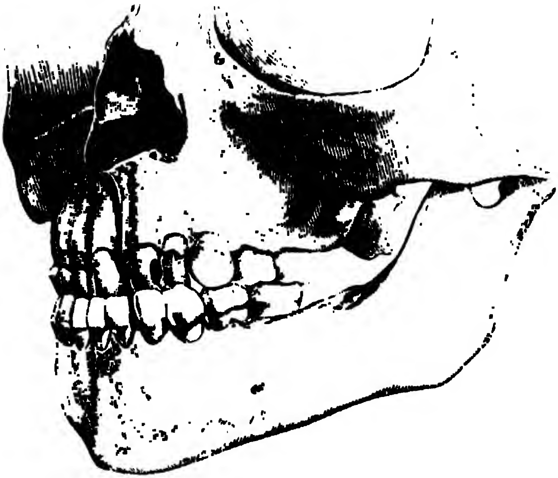
the inferior maxilla does not differ, either in general dimensions or in configuration, from the normal specimens; but the upper jaw in its alveolar portion is below the usual dimensions. The teeth are placed regularly, but the alveolar line is fully occupied, to the exclusion of the wisdom teeth; and the second molar closes upon the third molar of the lower jaw in the position usually assigned to the wisdom tooth, which, from its backward direction, is thrown altogether out of use.

The figure which illustrates the inversion of the upper teeth coincident with a well-grown upper jaw, is taken from a specimen in which the temporary teeth are present. In

(1) Showing the condition of the teeth and jaws in a specimen in which the anterior upper teeth were inverted coincidently with defective size in the superior maxilla.

this case we have an excess of growth in the lower jaw, the body of which is unusually long, and is associated with a

Fig. 46. (1)



ramus which has preserved the obliquity characteristic of an earlier age. The line of growth, as indicated by the position of the articular process, is calculated to give great length of jaw at the expense of depth in the posterior portions of the alveolar line.

The cause of this want of proper relationship between the upper and lower jaws and their respective teeth, is in many cases very obscure. In certain families it occurs as an hereditary character. In other cases, the deformity may

(1) Shows inversion of the upper front teeth coincident with unusual development of the lower jaw, the upper maxilla having attained the normal dimensions.

have been consequent upon the relatively tardy eruption or the inverted position of the upper teeth in infancy.

But whatever may have been the cause, the malposition will be persistent, unless remedied by mechanical interference. The under teeth will present a barrier to the outward movement of the inturned teeth.

If subjected to treatment at a sufficiently early period, these cases may be brought to a successful issue with much less difficulty than those in which the teeth are everted. The difficulty of keeping the teeth in the position into which they have been moved, is remedied by the antagonistic teeth of the lower jaw. When, therefore, the upper are brought sufficiently forward to close in front of the lower teeth, our treatment may be discontinued.

Now there can be no difference of opinion as to the propriety of adopting measures for reducing to a normal position teeth which are permanently turned inwards. We have therefore to consider the age at which the operation can be most advantageously undertaken, and the manner of performing it.

The anatomical conditions of the teeth, and the parts about them, at the period of eruption, have been already described. If these conditions are understood, but little doubt will be entertained upon the propriety of adopting mechanical treatment at a comparatively early period. There would be no advantage gained by waiting till the sockets are fully formed, as the treatment must then involve their partial destruction, and the reproduction of new ones. On the other hand, if the treatment be commenced sufficiently early, the large open sockets will allow the growing teeth to be moved forward,

and those parts of the sockets as yet unformed will be developed in accordance with the direction given to the teeth. So soon, therefore, as it is discovered that the upper fall within the lower front teeth, the treatment may be commenced. If measures were adopted prior to the establishment of irregular antagonism, we should perhaps be effecting by mechanical interference that which nature would have accomplished with much less inconvenience to the patient. Few can have failed to remark the much greater prevalence of irregularity in the permanent teeth about the time of their eruption, than at a later period, in that class of society the members of which do not avail themselves of the services of the dentist, excepting when the presence of an aching tooth can no longer be borne. That in many instances teeth which on their first appearance through the gums hold an objectionable position, will, if left to themselves, ultimately fall into the proper line, is a fact sufficiently well established to warn us against interference until it is clearly shown that our assistance is required.

Some difference of opinion exists as to the best mode of pressing the teeth outwards. The older method of procedure consisted in fitting a metal plate to the lower teeth, and projecting from the upper surface a plate of metal, which, on closing the mouth, passed behind the teeth whose position required change. In fact, the lower teeth were by this process artificially lengthened and turned inwards, and consequently the amount of force exerted upon the mal-placed teeth depended entirely upon the volutary action of the lower jaw in closing the mouth. In many cases this method of treatment will be successful, but it is slow, and consequently produces

a prolonged impediment to articulation and mastication, and it is open to a further objection. It is not uniformly successful, and when effective, depends in great part upon the voluntary efforts of the patient.

More recently, ivory plates fitted to the palate, and extended over the molar teeth, have been adopted. The ivory over the masticating surfaces of the molar teeth is left sufficiently thick to prevent the upper and lower front teeth from influencing each other when the mouth is closed. The plate is fitted to the necks of the teeth to be operated upon, between which and the plate portions of dry compressed wood are placed, in cavities cut in the ivory for their reception. Each instanding tooth will have its corresponding cavity in the plate, the formation of which requires some little attention. The form should be similar to that of a shallow drawer, the front of which has been removed, and so proportioned as regards the upper and lower surfaces of the plate in which it is cut, that the section of wood will not fall out into the mouth. The wood should be fitted to the cavity, and left a little thicker at that end which lies towards the gum. The plate having been adjusted to the mouth, holes must be drilled through it for the admission of ligatures, which may be passed round and tied to one or other of the molar teeth on each side of the mouth.

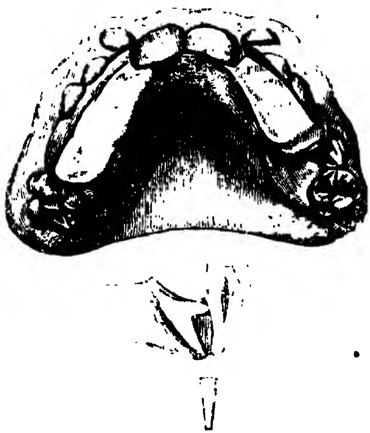
In arranging the ligatures, care must be taken that they do not press upon and irritate the gums. It will be remembered that the gums approach nearer to the masticating surfaces of the teeth on the lingual than on the labial side. Hence, the holes in the plate should be made at the point corresponding to the free edge of the gum against which it rests, and continued obliquely in a direction continuous with the line fol-

lowed by the gum in its passage between the teeth. If this precaution be observed, the ligature when tied will pass in a straight line from the labial surface of the tooth to the lingual surface of the plate, without interfering with the gums. In selecting the teeth around which the ligatures are to be passed, we must be guided by the forms and the position of the teeth available for the purpose; but should the temporary molars be present, it will be well to make use of them in preference to the permanent teeth. The abrupt termination of the enamel renders them particularly suitable for the purpose, and the short period during which they will be retained renders their injury a matter of little consequence.

By the foregoing means the plate may be firmly fixed preparatory to the introduction of the compressed wood, the cells for the reception of which will be formed on the one side by the teeth to be moved, and on the other three sides by the plate. After compressing for some hours a piece of dry willow, plane, or some other soft wood, small strips may be cut off, and from these fragments must be prepared which will fit with moderate accuracy to the spaces formed by the plate and teeth, taking care that the grain of the wood runs parallel with the long axes of the teeth. So soon as the wood commences to absorb moisture it will expand, and in a direction transverse to that of its grain. In expanding, either the tooth in front of it must move outwards, or the plate must be driven backwards, and with it the molar teeth to which it is fitted. But as the front teeth are capable of the least resistance, they are the first to yield, and therefore gradually advance before the expanding wood. From time to time the wedges must be renewed, each new piece being

slightly larger than its predecessor; and as the teeth move upon an axis situated near the apices of their respective

Fig. 47. ([1])



roots, the receptacles become changed in form, and it will be necessary to modify the form of the grooves in the ivory plate. If this precaution be neglected, there will be a difficulty in retaining the wood after the teeth have been moved from their original position. The receptacle will have changed in form as respects the relative size of the upper and lower

([1]) Showing an ivory plate fitted to the upper jaw, for the purpose of forcing outwards the central incisors. The ivory is left sufficiently thick over the masticating surface of the back teeth to prevent the lower teeth from influencing those to be operated upon. The plate is retained by ligatures passed through the ivory and round the temporary molars; posterior to the central incisors, the apertures of the cells for the reception of the compressed wood are shown.

Below the figure, a section of the parts *in situ* is given, showing the cell in its length, with the piece of wood removed and placed underneath. I am indebted to my friend, Mr. Harrison, for the specimen from which this figure has been taken.

portions. Hence it becomes necessary to deepen that end of the groove which lies near the gum, and the excavation must be made sufficiently deep to restore the parallelism which has been lost by the outward movement of the tooth. When the required amount of change in position is considerable, and the half of this has been gained, it may be necessary to discard the original plate, and substitute a new one fitted close to the teeth operated upon, so as to admit a thinner and more manageable wedge than that which would have been required had the treatment been continued with the first made apparatus.

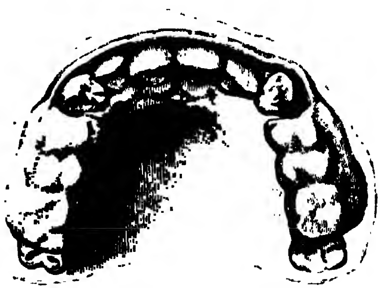
It is doubtful whether, as a general rule, more than two teeth can be advantageously operated upon at the same time. If, for instance, the four incisors are involved in the irregularity, it may be desirable to push forward the central teeth first, and then move the lateral teeth, or *vice versâ*. But in adopting this plan we must not neglect to take means to prevent the teeth first operated upon from retreating to their old place while the others are being forced forward. This may be accomplished by inserting into the ivory frame pegs of wood, the free ends of which rest upon the backs of the moved teeth. In this application of the wood the end of the grain will rest upon the tooth, and as there is but very slight expansion lengthwise of the grain, the teeth will be simply held in position.

When the whole of the instanding teeth have been moved outwards to an extent sufficient to ensure their passing in front of the lower teeth on the mouth being closed, the use of the apparatus may be discontinued. Sometimes, however, it will be found that the back teeth of the upper and lower

jaws, from having been kept apart during the treatment, lose their proper antagonism. They become raised in their sockets, and prevent the front teeth from meeting each other; under these circumstances, those portions of the ivory plate which extended over the masticating surfaces of the back teeth must be removed so as to allow the teeth to come in contact, while the plate prevents the front teeth from falling back into the former position. In a few days the proper antagonism will be restored, and the plate may be discarded.

Instead of using ivory, metal may be used for the plate. The molar teeth on either side are capped with gold, the caps being made so that they fit tightly upon the teeth. From these a band of metal is extended in front of the teeth. Holes are drilled in the band opposite to the teeth, and strong silk thread is passed round the neck of each tooth and through the corresponding holes, and tied tightly on the outer

Fig. 48. (1)



(1) Shows metal caps fitted to the molar teeth, with a band extending from them in front of the incisors. To the metal band so fixed, ligatures, after being passed round the front teeth, were attached, and drew the inverted teeth forward until they came in contact with the band. The case was treated by Mr. Harrison, to whom I am indebted for the specimen given in the figure.

surface of the band. The teeth will by degrees be drawn towards the band, but the process is a slow one, and requires frequent renewal of the ligatures.

I have commonly used vulcanized caoutchouc in the place of silk; with this material, the tension is more uniform, and the renewals need not be made so frequently. The fixing of the india-rubber to the band was at first a difficulty; tying was impracticable, and hooks could not well be used. I found, however, that by cutting fine slits with a hair-saw obliquely through the metal band, and then passing the two ends of the caoutchouc in a state of tension into them, the ligatures were firmly retained. Silk ligatures require renewal every second day, but the caoutchouc will last double the time, and will produce a much more rapid effect. I have in favourable cases succeeded in bringing teeth out in the course of a fortnight, and the case has been dismissed.

In the place of using metal in the foregoing manner, a plate may be fitted to the palate, and retained by bands passing round the back teeth, or by portions of wire extended over the crowns and bent down so as to clasp the necks of the teeth. To the palatal portion of the plate, bands of metal rendered elastic by hammering, may be attached, adjusting the free ends so that they shall press upon the backs of the malplaced teeth. This manner of proceeding is inferior to the two preceding methods where a number of teeth are involved, although in cases where two or three teeth only are required to be shifted, not only outwards or inwards, but also upon their axes, it offers some advantages.

The treatment upon the principle of elongating the lower teeth, need not be recurred to, but the relative advantage of

operating with ivory and metal may be considered; and this opportunity may be taken for treating the subject upon its general merits, without reference to any special description of case. Excepting in those cases where the antagonistic teeth serve for maintaining the position acquired by mechanical interference, regulation plates must be worn for many months, and whatever may be the material used in their construction, the teeth to which they are attached gain nothing by being so used. Metallic bands encircling natural for the support of artificial teeth, not uncommonly produce injury to the former; and it is fair to infer that when, in protracted cases, regulation plates are retained by similar means, some amount of mischief may result. Hence there are those who condemn the use of metal. Mr. Harrison, to whom I am indebted for the results of his experience, tells me that he uses ivory exclusively, objecting to metal on the ground stated above. The question arises as to whether ivory is really less injurious to the invested teeth than gold; and judging from the experience gained by watching the effects of artificial teeth constructed with each, I think we shall be constrained to answer in favour of the former. Still, before any appreciable hurt can be produced, the metallic frame must be worn for a long time, and supposing it can be attached to temporary teeth, this consideration need not influence our selection.

The advantage in respect to time and the relative amount of inconvenience entailed upon the patient by the one or other method of procedure, must not be disregarded. The ever-varying character of the cases renders it difficult to lay down any general rule as to the advantages of the one method over the other as regards the time required to produce the desired

effect. But owing to the difference of bulk, the discomfort to the patient will generally be less with a metal than with an ivory plate. When the latter is used, the plate must have considerable thickness, especially at those points where the wedges are inserted; and, as a natural consequence, the utterance of the patient will be considerably impeded.

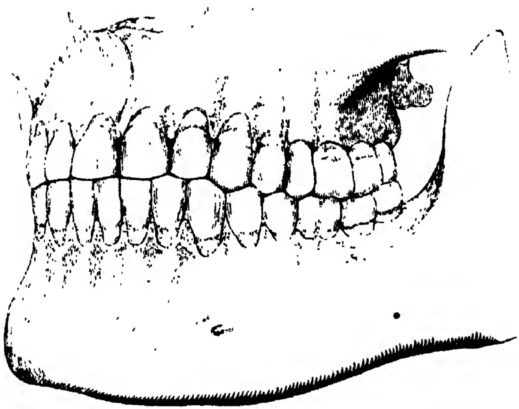
In common with many others, I have sometimes failed when using ivory, in consequence of having, at the solicitation of the wearer, reduced the plate so thin that the retention of the wood became a matter of difficulty. If, however, this material be employed, the importunities of the patient must be resisted. Then, again, the ligatures, unless very nicely adjusted, produce great annoyance. These inconveniences are entailed in a less degree when a metal plate is used, still, even metal cannot be worn without a certain amount of discomfort.

So far as my own experience has gone, I cannot say that I have seen any permanent injury produced by the use of metal in regulation cases, and generally the cases which have been treated by this method have been brought to a more rapid conclusion than those in which ivory has been employed; still, unless in exceptional cases, I am not prepared to advocate strongly the advantages of metal over ivory as a material for constructing regulation plates.

Intermediate between the two forms of irregularity already described, is that in which the front teeth meet *edge to edge*, as shown in the accompanying figure (Fig. 49). It may be regarded as differing in degree only from those cases in which the upper front teeth are inverted, and as dependent upon similar causes operating with less force.

A form of irregularity involving more or less the whole of the teeth is found associated with an abnormal development

Fig. 49. ([1])



of the maxillæ. In the description of case alluded to, the molar teeth, on closing the mouth, alone come in contact; while the upper and lower incisors, without being either unduly turned outwards or inwards, stand apart.

In the specimen from which the illustration is taken (Fig. 50), the degree of separation is moderate in amount, as compared with many cases presented to the practitioner; but it affords an opportunity of showing a peculiarity in the conformation of the lower jaw usually coincident with this form of irregularity. It consists in a great development of the anterior part of the jaw in the vertical direction, with a diminished depth in the parts which sustain the molar teeth, associated with an un-

([1]) Showing the front teeth meeting edge to edge.

usual obliquity of the ascending ramus. The line of growth in the latter part has not taken the rectangular direction

Fig. 50. [1]

which characterizes the well-formed adult jaw. The anterior part of the alveolar ridge of the upper maxilla has not attained the normal depth—a peculiarity which the accompanying illustration does not exhibit in the degree commonly seen in cases of this nature. I have seen several instances in which in the closed mouth the finger could be passed between the front teeth.

The teeth themselves, and especially the first permanent molars, usually present indications of imperfect development of their tissues. The surface of the enamel is irregular, and marked with pits and transverse grooves, is yellow in colour, and readily broken down.

(1) Showing that conformation in which the molar teeth only come in contact when the mouth is closed, and the peculiar form of the lower jaw coincident with the imperfect antagonism of the teeth.

The anatomical conditions which are coincident with this form of irregularity are readily distinguished, but the causes which have destroyed the relations of the several parts of the jaws during development are very obscure. In most instances the patients have been unable without effort to breathe through the nose, and the mouth has consequently been habitually kept open, even during sleep. Possibly the constant traction exercised upon the anterior part of the jaw in keeping the mouth open may have had some influence in determining the peculiarity of form, and the freedom from the pressure exercised mutually by the antagonistic molar teeth upon each other, may have led to their rising higher with their sockets than they do when their conformation is normal.

I have attempted to diminish the amount of deformity in one case only. The patient was a female, twelve years old. The front teeth were separated by a wide interval when the first molars were in contact, and the lips closed with difficulty. The chin, although retreating, was of unusual depth, and, associated with the unclosed lips, gave a vacant expression to the face. The method of treatment which offered the greatest prospect of success consisted in maintaining a steady upward pressure upon the anterior part of the lower jaw, leaving the antagonizing molar teeth to act as a fulcrum. A sheet of gutta-percha was moulded to fit the point of the chin, and a cap fitted to the head, and the two were connected by strong bands of caoutchouc—one on each side. The amount of pressure exerted by this contrivance was sufficient to produce tenderness in those teeth which closed upon each other. This source of discomfort passed away of itself in the course of a fortnight, without any modification of the plan of treatment.

At the end of three months the front teeth, which at the time the treatment was adopted were separated by three-eighths of an inch, now came in contact, and the general appearance of the face was greatly improved. The patient was directed to use the apparatus during the night time for at least six months, and to show herself at the expiration of that period. These instructions were disregarded, and it was only after a lapse of two years that she was again brought to me. The deformity had returned with the eruption of the second permanent molars, the masticating surfaces of which teeth alone came in contact when the mouth was closed. The treatment which two years before had been attended with a fair amount of success was again adopted, but either from want of perseverance or from the increased age of the patient, a slight advantage only was gained. Had the patient persevered from the first in the course she was directed to follow, the deformity would to a great extent have been overcome. In examples of the form of irregularity under consideration, the most striking and the most important feature is the obliquity at which the ramus is placed with respect to the body of the lower jaw. The line of growth has been almost directly backwards, and the inferior dental canal, instead of being carried upwards in its posterior third, is almost straight from end to end. That form in which the rectangular position has been prematurely assumed, and the ascending ramus below the usual height, has already been adverted to. Here we have a class of cases in which the obliquity peculiar to infancy has been maintained throughout the whole period of growth, and as a consequence, an alveolar line of unusual length is produced. In the prematurely rectangular jaw we seldom

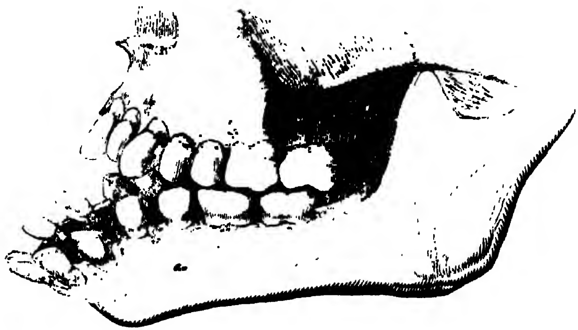
find sufficient space for the normal implantation of the wisdom tooth; in the oblique maxilla, on the contrary, there is room even for a fourth molar.

The specimen from which the preceding figure (Fig. 50) has been taken, affords a better opportunity of examining the anatomical relations of the several parts of the jaw than is afforded in the living subject. In this we shall see that, had the alveolar portion been developed in accordance with the usual form, while the obliquity of the line of development was preserved, the separation of the front teeth would have been far greater than it is; but nature having departed from the normal form in one particular, to a certain extent counterbalances the deformity by a deviation in another direction. Here, the alveolar processes at the back part are unusually shallow, and in the front part of the jaw are unusually deep; the back teeth are kept down to a low, and the front teeth are raised to a high, level. The treatment adopted in the case already cited, was in accordance with the indications afforded by the specimen; the back formed the fulcrum by the aid of which the elastic bands pressed the front part of the jaw upwards, and drew the ramus downwards.

The following interesting case shows to what extent the form of the jaw may be modified by the maintenance of constant pressure during early life. The patient was a strong healthy young woman, twenty-two years of age. Her chin was drawn down toward the sternum by a broad cicatrix, consequent upon a burn received when five years old. The teeth of the lower jaw stood out almost at right angles, and were far in front of those of the upper jaw. The accompanying illustration is taken from a cast made when the patient was in

the Middlesex Hospital, and shows accurately the position of the teeth and the form of the alveolar ridge. The position

Fig. 51. (1)



and the proportions of the lower border of the jaw and the ramus being enclosed by a tense hard cicatrix, could only be guessed. The accuracy, therefore, of the illustration as respects the hidden parts cannot be depended on. The injury occurred after the temporary teeth were matured, but prior to the eruption of the permanent organs. Hence the traction exerted by the cicatrix in opposition to the natural action of the jaw, and of the endeavour to keep the face in the natural position, came into operation when the permanent teeth were passing through the gums, and when their alveolar processes

(1) Drawing taken from a cast of the upper and lower teeth and gums of a patient, aged twenty-one, who at the age of five years was badly burnt about the neck and chest. The chin was, by the contraction of the cicatrix, gradually drawn down towards the chest, and the alveolar portion of the lower jaw became everted in the manner shown in the figure. The teeth are perfect as regards number, and are tolerably well formed. The outline of the bones has been added by the artist, and hence must not be depended on as faithful representations of the condition of those parts.

were growing up with them. As the permanent alveoli were for the most part developed under the influence of the ever-contracting cicatrix, we shall be justified in assuming that they were originally formed in the everted position shown in the figure, rather than that they were developed in the normal position, and bent outwards and downwards subsequently. But whatever explanation may be adopted as regards the process by which the deformity has been produced, the case offers a very instructive illustration of the amount of change in form that a force incessant in its operation may bring about in the jaw during the period of growth.

There is yet another form of irregularity in which the whole of the teeth of one or of both jaws are more or less involved. It is that which is commonly called the V *or wedge-shaped mouth;* the teeth, in place of holding the elliptical arrangement, occupy two converging lines which meet at an angle in the anterior part of the jaw, producing, as an almost invariable result, an extremely high and vaulted palate. The position of the teeth on the two sides of the jaws may be perfectly symmetrical, and the conformation may correspond in the upper and lower maxillæ. More commonly, however, the deformity is confined to, or exists in a much greater degree in, the upper jaw, the central incisors of which frequently slant forward and stand far in advance of those of the lower maxilla. Each case will present its special peculiarities. In one, the median sides of the central incisors will project forwards and meet at an angle; in another, angles will be formed at the junction of the lateral and central incisors; in a third, the central incisors will form at the junction of their median sides an angle directed inwards, and with

their distal sides and the median sides of the lateral incisors, two angles directed outwards not unlike an inverted W. The deep vaulted form of the hard palate is sometimes carried to such an extent as to suggest the idea of the two sides of the jaw having been forced towards each other, and the roof of the mouth driven upwards. In other cases the height is not greater than would necessarily result from the substitution of the vertical for the oblique positions of the alveolar portions of the jaw, and it is not uncommon to find that the height, although apparently in excess of the normal elevation, does not in measurement exceed that of a finely developed maxilla.

It will not, however, be necessary to enter into all the minor modifications of form presented in cases where this character of deformity prevails. Although numerous examples present themselves in which parentage cannot be adduced as a cause for V-shaped dental arches, yet in many families this peculiar conformation of the mouth will be found as an hereditary characteristic. But through whatever influence the defect may have primarily arisen, it is the result of a departure from the normal anatomical relations between the teeth and the jaws, and as the size of the former is determined some years before the latter have arrived at their ultimate dimensions, we can but regard the fault as originating in the jaws.

Before tracing the source from which the maxillary defect has sprung, it must first be determined whether the base of the jaw is imperfectly developed, or whether the deformity is confined to the alveolar ridges. In the one case, the base of the maxillæ will be below the normal size; in the other, the alveolar portions of the jaws will have taken an irregular direction.

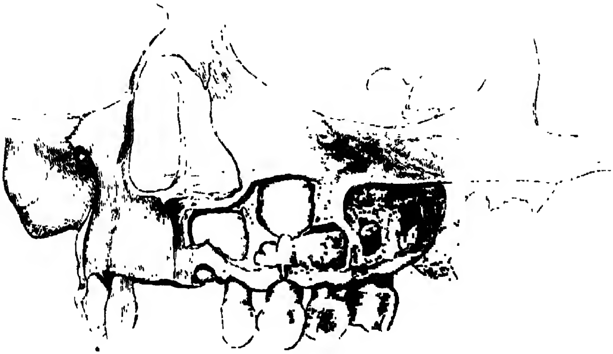
If the process of outward growth during the presence of the temporary teeth has been defective, and the permanent teeth while within the alveolar crypts have been forced to take such a position as the space allotted to them would allow, on successively appearing through the gums they will necessarily present the irregularity of arrangement into which they had fallen during development. But if the base of the alveolar portion of the jaws has reached the normal dimensions, the teeth, although mal-placed at the time of eruption, may ultimately become regular, as at this period the alveoli have yet to undergo modification and further development.

If some of the preceding figures be examined and compared with those in which the arrangement of the two sets is normal, the manner in which irregularities arise may be seen. In studying the causes which produce the mal-positions in which the whole of the anterior teeth are involved, the investigation must be commenced prior to the eruption of the permanent teeth.

It has been usual to assume that the premature extraction of the temporary teeth occasions contraction of the jaw, but I do not think that any anatomical facts can be brought forward in support of the supposition. If a temporary tooth be removed, the crowns of the contiguous teeth may lean towards each other, and give an appearance of contraction, but it does not really involve a diminished size of that part of the jaw from which the tooth has been lost. In the case from which the accompanying illustration is taken, the two central incisors were lost long before their successors were ready for eruption; hence the sockets became obliterated, and the

alveolar ridge made good; but we do not see the slightest trace of contraction in the jaw.

Fig. 52. (1)



Then again, if specimens be examined in which the two sets of teeth are present, it will be seen that the implantation of the temporary teeth occupies but a very small space in the alveolar ridge, as compared with that occupied by the crowns of the permanent teeth. Now, it is extremely difficult to conceive how the removal of the temporary teeth can induce the jaw to contract upon the crowned and growing permanent teeth. Organs in an active state of development induce the expansion of parts about them, and there is no good reason for supposing that the jaw forms an exception to this rule. The persistence of the first, which are placed immediately in front of the second set, may, and frequently

(1) The upper jaw of a subject between six and seven years old. The central incisors had been lost, and the alveolar ridge had become rounded by the obliteration of the sockets of the temporary teeth and the development of new bone. If the premature loss of the temporary teeth were followed by contraction of the jaw, the condition should be shown in this case.

does, interfere with the outward progress of the latter; but I cannot see how the removal of the temporary can produce a prejudicial influence upon the arrangement of the permanent teeth. In the case shown in Fig. 52, the temporary incisors have been shed some time prior to the eruption of their successors; yet there is no indication of contraction of jaw. A case came under my notice recently, in which the child had been destitute of temporary teeth, excepting only the second temporary molar on the right side of the lower jaw; the maxillæ were, notwithstanding, well formed, and the permanent teeth appeared with an unusual regularity of arrangement. Had the development of the jaws depended upon the presence of temporary teeth, we should surely have seen in this case some amount of contraction.

Subsequently, however, there may be some amount of practical inconvenience resulting from the premature removal of the temporary teeth, but it is altogether independent of contraction of the jaw. The newly-cut incisors, in the absence of adjoining teeth, will sometimes lean away from the median line, leaving a central opening between them. This is, however, an evil that generally cures itself. The canines and bicuspids, when they appear, force the slanting teeth into the vertical position, and the space becomes obliterated.

It may in some respects be disadvantageous to remove the temporary teeth prematurely, but the disadvantages will not be shown in the mal-position of the succeeding teeth at the period of their eruption. But should the first teeth be retained beyond the normal period, the mischief resulting from their presence will be sufficiently obvious. When the subject of partial irregularity is considered, this point will be rendered evident by the accompanying illustrations.

Before the course of treatment is decided upon, the conditions presented by the jaws must be accurately ascertained, and it should be known whether the deformity is hereditary or accidental; and it must also be ascertained whether the jaws are contracted at their bases—at that point where the alveolar portion merges in the body of the bones. And it is equally important that we should learn whether the mal-position of the second, has arisen from the tardy shedding of the temporary, set. If the case presented for treatment exhibits a form common to the family of which the child is a member, we shall probably have to encounter greater difficulty than if it be a solitary example. After the teeth have been removed, there will be a greater tendency in the one case than in the other to return to the original position. Supposing the V-shaped arch be forced into the elliptic form in a case where the base of the jaws is below the normal size, the position of the teeth individually will be so oblique, as respects the jaw, that they will become unsightly; and moreover, it is questionable whether the subsequent alveolar development will be sufficient to secure a firm implantation. Hence, in cases which present this character, it may be desirable to remove permanent teeth, one on either side of the jaw, more especially when the front teeth are unduly prominent, and consequently require to be brought inwards. If the mal-position has resulted from the persistence of temporary teeth, there will be a strong natural tendency on the part of the permanent teeth to fall into the elliptical arrangement so soon as the obstruction is removed.

When there is every reason to suppose that the base of the jaw is free from contraction, the teeth may then be forced

outwards till the desired conformation is attained; and in cases where the deformity has been equal both in the upper and lower jaws, and the antagonism perfect, it will be necessary, after the upper teeth have been re-arranged, to repeat the operation in the lower teeth, and thereby restore the antagonism which would otherwise be disturbed, and in the efforts of re-adjustment, influence unfavourably the results of the operation.

The form of apparatus suitable for expanding the V-shaped dental arch need not be minutely described, as either the ivory or the metal plate—a description of each of which is given in connexion with the treatment of inverted teeth—will be found effective.

In the succeeding figure, furnished me by Mr. Harrison, the deformity is so great, and the base so contracted, that successful treatment would be attended with great difficulty. The bicuspids were removed with the hope that the front teeth would fall back; but, with the eruption of the wisdom teeth, the first permanent molars moved forwards into the vacant spaces, and the more anterior teeth preserved their original position. It would appear in this, as in many other cases, that nature, having recognised a special, though an irregular form, offered resistance to any subsequent change (Fig. 53).

Hitherto attention has been directed to those cases only in which the front teeth, though uniform as regards their individual arrangement, have been as a whole out of the natural position. Instances in which some of the teeth are mal-placed as respects the crowns, while the remainder hold the normal position, have now to be considered.

Separation of the central incisors, leaving an unoccupied

space in the mesian line, is perhaps the most simple, and at the same time the most manageable, form of irregularity

Fig. 53. (1)

which comes under our notice. If the teeth are otherwise correctly placed, a ring of india-rubber stretched over the two teeth will in the course of a few days bring them together, after which the occasional use of the ring or of a silk ligature will be sufficient to retain the teeth until they become fixed in the new position.

Inversion or eversion of the central incisors is not uncommonly seen in cases where the ejection of the temporary teeth has been delayed, and the successors have come through either behind or in front of them, or when the eruption has

(1) Shows a case in which the V-shaped conformation was attended with unusual contraction in the neighbourhood of the bicuspid and first permanent molar teeth. On the left side both of the bicuspids were removed, and in the right the second bicuspid was extracted without any advantage being gained as regards the contracted condition of the palate. I am indebted to Mr. Harrison for the use of this interesting specimen.

been postponed until the lower teeth have attained their full height, and in the absence of any counteracting influence from antagonistic teeth, have either taken a higher or a more forward position than they should have done; and consequently driven the upper teeth, when in a state of active growth, either outwards or backwards, just as they may strike on the labial or lingual surfaces immediately after emergence.

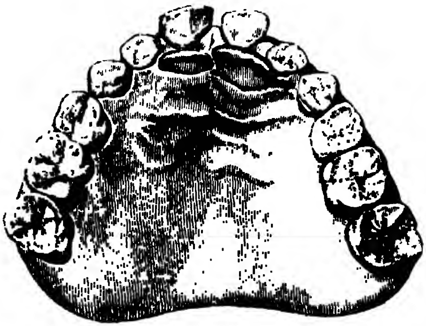
On the other hand, the lateral incisors may, as in the case figured at page 68, lie in front of the central teeth during development, and the four teeth, advancing in growth with equal rapidity, oblige the latter, at the time of eruption, to take a backward place.

But by far the most common cause of displacement is the persistence of the temporary teeth. The following figure may be taken as a fair example of irregularity arising from this cause. The temporary teeth being retained, their successors have consequently taken a posterior position, which allows the lower teeth, when the mouth is closed, to pass in front of them; and thus, in the absence of mechanical interference, render permanent the mal-position.

Whatever may be the cause of the irregularity, the difficulty involved in its reduction will not be great. In case they are directed inwards, the use of either a metal or an ivory plate, provided with chambers for compressed wood, will speedily force them into a sufficiently forward position. Or they may be dragged outwards by caoutchouc bands passed through a slit bar of metal, passing in front in the manner already described. If the fault be undue prominence, this may be overcome either by an elastic band of metal attached to the labial

surface of caps fitted to the molar teeth; or by silk ligatures passed through a plate adapted to the hard palate, and over

Fig. 54. (1)



portions of compressed wood, which have been fitted in square chambers produced on the lingual surface for their reception. When applied in this manner, the wood will expand in the inward direction, and consequently carry the ligatures backwards, and with them the outstanding teeth. Should the mesial edges of the lateral teeth be so placed that the inward movement of the central incisors is obstructed, our treatment must commence by forcing the former outwards from the median line, until they cease to embarrass the operation. This may in most cases be done by placing pieces of india-rubber between the lateral and central teeth. It is scarcely necessary to repeat, that when the lower teeth close in front or upon the edges of the upper, the plate must be made suffi-

(1) **Shows the permanent central incisors coming through the gum posteriorly to the persisting temporary teeth, leaving an interval into which the lower incisors pass when the mouth is closed.**

ciently thick at those parts which pass over the back teeth to prevent the antagonistic influence.

Torsion, or twisting of the central incisors upon their axis, is far from rare. The defect in position may be common to, and equal in each tooth, or it may be greater in the one than in the other, or it may be confined to one tooth only. Either the mesial sides may be directed towards the palate, or they may be turned towards the lips (Fig. 26), or the one tooth may be twisted in the one, and the fellow tooth in the other direction. (Fig. 28.)

In a case recently under treatment, the right incisor made its appearance at the age of thirteen, with the lingual surface parallel with the median line of the mouth. In this case the tooth is a quarter of a turn out of place, but instances are recorded in which the twisting has extended to as much as half a turn, so that the lingual surface presents to lips. I have one example showing this amount of torsion in a bicuspid tooth. In many cases of this kind the mal-position has been assumed during the period of development, and is then consequent upon arrested development of the anterior part of the jaw. Sometimes, however, it results from the retention of the temporary incisors. And it is not improbable that the root of a temporary tooth, if displaced by a blow or by a rude operation, may disturb and turn the successor upon its axis while within its crypt. The retarded development or eruption of a tooth may also be cited as a cause of its torsion; and it is not difficult to see how the mal-position is then produced. The adjoining teeth being already through the gums, lean toward the unoccupied space, and offer an impediment to the progressing tooth, which, from its comparatively loose

implantation at the eruptive epoch, turns on its axis, and descends or ascends, as the case may be, in that position in which the least resistance to its progress is offered.

In no case is it desirable to lose a central incisor; hence, if we have reason to suppose that the twisted tooth is in itself perfect, it must be brought to the proper position; and should it appear impossible to obtain sufficient space without sacrificing a tooth, we must remove one or other of the more posterior teeth.

It is quite possible cases may occur in which such a proceeding becomes necessary, although I have rarely met with them in my own practice. But before deciding upon sacrificing a sound tooth, we must be well assured that the incisor is not subject to deformity, like that shown in Fig. 43, where the descent being arrested by the presence of a supernumerary tooth, the fang has been developed in an irregularly curved form. Instances will sometimes present themselves in which the exposed portion of the crown is twisted and directed towards the palate, while the root of the tooth is in the usual position, the crown and the fang being joined at an angle, presenting that peculiarity of conformation which has been denominated dilaceration. [1] If in such a case a healthy tooth were removed, we should be committing a serious error. It therefore becomes necessary that a very careful examination of the mouth should be made before the treatment is determined on. The position of the root of the erring tooth should be ascertained, and this may generally be done by a careful examination of the gum, beneath which the outline of the root, if in the usual position, may be felt.

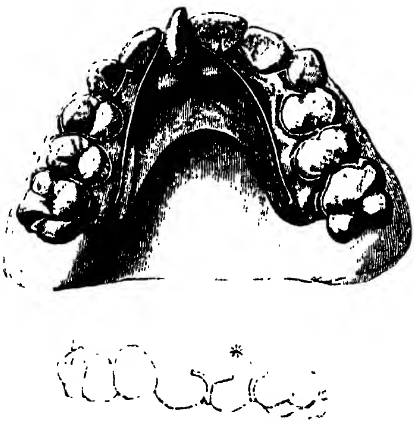
[1] Lectures on Dental Physiology and Surgery.

It is scarcely necessary to remark, that when the necessity for the removal of a tooth arises, our choice will fall upon an unsound one, should such be present, even though it be at some distance from the point where the space is required.

As respects the treatment to be adopted, I cannot do better than describe the course pursued in the following case, inasmuch as the illustrations necessary for the elucidation of details will serve the further purpose of showing the method applicable to cases of irregularities affecting other teeth. The patient was a female, aged fourteen years. The left central incisor up to the age of thirteen did not make its appearance, consequently the crown of the right lateral and left central teeth leaned towards each other, leaving an interval insufficient for the missing tooth to take its natural position. At thirteen, however, the tooth appeared, with its median side directed towards the lip, but it was not till a year had elapsed that the case came under treatment. The succeeding figure will show the general position of the teeth, and it may be remarked that the canines were slightly more prominent than the anterior teeth. A careful examination led to the conclusion that, supposing the laterals and the left central incisor were pressed out, so as to range evenly with the canines, sufficient space would thereby be gained to allow the twisted tooth to hold the normal position. Acting under this impression, a plate was made to fit the palate, and attached to the bicuspids by wire continued over the crowns of those teeth on either side of the mouth, and terminated by a small T-like extremity, which, by way of protecting the teeth, was covered with a thin investment of floss silk. In this manner the plate was firmly retained in its place.

The next proceeding consisted in soldering to the back part of the plate two bands, composed of gold, rendered elastic by the addition of three grains of platinum to one pennyweight of the ordinary eighteen-carat gold. The free ends of the bands were adjusted to press outwards and from the irregular tooth, the two contiguous teeth, in the manner shown in the accompanying figure.

Fig. 55. [1]

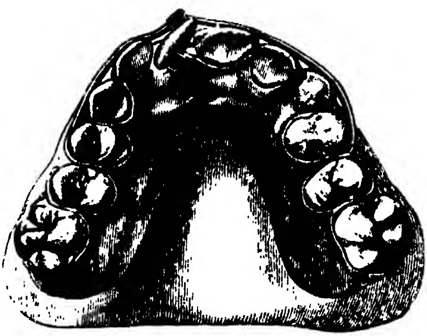


In the course of nine days, sufficient effect had been produced to render it desirable that the incisor itself should be acted upon in order that the increased interval should be

(1) Shows the right central incisor twisted on its axis to the full extent of a quarter of a revolution, with the adjoining incisors in close contact with its labial and lingual surfaces. The metal plate used in the first stage of the operation is shown *in situ*, with the two elastic bands of gold soldered to the back part of the plate, and the free ends in a position for separating the right lateral and left central incisor in order to gain space for turning the displaced tooth. In the sketch below, the manner of adjusting the wire bands for the retention of the plate is shown.

occupied by the tooth for which it had been obtained. A second plate was constructed. In this a bar of gold was continued in front of the teeth, and attached to the anterior T-piece on either side. Metal cells for the reception of compressed wood were then soldered to the plate and to the band. One was placed so that the wood would press upon the distal angle of the tooth, the other upon the labial surface near the median angle. The forces thus brought into play acting in opposite directions, turned the tooth upon its axis, and were sufficient to influence the impinging lateral and central teeth, and force them out of the way of the slowly turning tooth. In

Fig. 56. (1)



a few days it became necessary to alter the position of the receptacles for the wood, and subsequently to move them

(1) Shows the condition of the case illustrated in the preceding figure after the adjoining teeth have been separated by the elastic bands, and the displaced tooth turned slightly from its original position. The plate used in this, the second stage of the operation, is shown *in situ*, with the metallic boxes for the reception of the compressed wood in the positions suitable for effecting the further progress of the treatment. It will be apparent that the boxes will require a change of position when the tooth has moved away from them.

from time to time towards the retreating angles of the tooth.

After the second plate had been in use three weeks, the tooth had so far changed its position that the mesial side stood slightly in front of the left incisor, and the distal side a little posterior to the lateral incisor, presenting a degree of irregularity which would attract but little notice.

As the left incisor was still a little internal to the arch which would be described if the canines were taken as the guide for its formation, a cell was adjusted upon the plate behind that tooth, and the wood brought into operation. At the same time, the operation upon the lingual surface near the distal angle was continued, and the degree of pressure upon the labial surface was considerably reduced. In the course of a second term of three weeks, the tooth was brought into position, ranging evenly with the contiguous teeth.

The foregoing illustration will show the principles upon which the operation was conducted, although the wood-retaining cells are given in one position only. It must be understood that they were moved from time to time, so as to follow up the moving tooth, and so adjusted as to bring the pressure to bear in such directions as at the time appeared to be required.

This case will be regarded as one presenting a considerable amount of difficulty. A successful operation involved not only twisting a tooth upon its axis to the extent of a quarter of a revolution, but also the shifting outwards of the left central and both of the lateral incisors, in order to make room for the crossing tooth to turn. The base of the alveolar was, how-

ever, sufficiently developed to render the readjustment of the teeth practicable without having recourse to extraction.

The front teeth having been carried into the desired position, it became necessary to take measures to keep them there until they became firmly fixed in their sockets. To effect this retention, an ivory plate was fitted to the palate and to the lingual surfaces of the teeth, extending as far back as the first permanent molars. The bicuspids being a little internal to the proper outline of the arch, pegs of wood were inserted into the ivory at the points corresponding to the necks of these teeth. After adjustment, the pegs projected from the plate sufficiently to press firmly upon the four instanding teeth, and thus perform the double purpose of retaining the plate in its place, and of forcing the teeth, upon which its retention depended, slightly outwards. This, then, is the condition of the case at the time I am writing, and I feel no doubt that before the expiration of twelve months the teeth will have settled down in their present position.

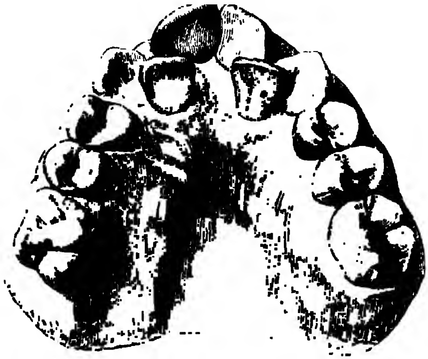
Irregularity in the position of the lateral incisors.—In the upper jaw these teeth may be misplaced in either of the directions described in connexion with mal-position of the central incisors—hence the description which has served for the one may be applied to the other series of deformities.

Perhaps the most common form of irregularity of the lateral teeth is that in which they take a posterior position, the median edge of each lying behind the contiguous side of the central incisor, and the distal edge behind the median side of the canine.

In the example figured, the teeth have retained the position assumed during their development, when, from the retarded

growth anteriorly of the jaws, this or some other form of displacement was necessitated. The canines here hold the place

Fig. 57. (1)



which should have been occupied by the lateral teeth, but had the latter taken their normal position, the former would have been thrown out of the dental line.

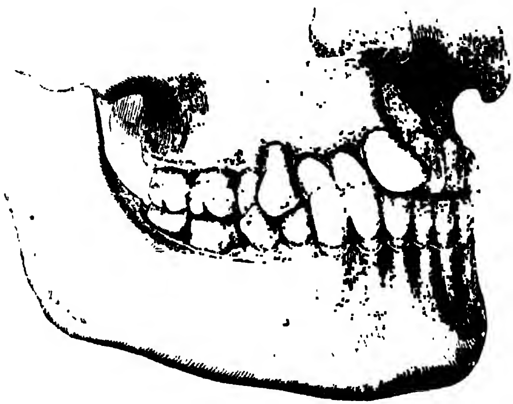
We must not, however, in endeavouring to trace the cause of mere misplacement in cases like the one figured, forget that had a proper direction been given to the teeth as they successively appeared through the gums, the alveoli would have grown up with them, and if the base of the jaw had attained a sufficient size, no irregularity would have occurred, even had the teeth, when within the jaw, been somewhat irregularly disposed.

In the case from which the succeeding illustration is taken, there is no indication of contraction of the jaw.' On the one

(1) Showing the lateral incisors placed internal to the dental arch, the alveolar arch being contracted. This illustration is taken from a cast of the mouth.

side of the mouth, the teeth are perfectly regular; on the other, the lateral incisor and the canine are directed inwards, and pass, when the mouth is shut, behind the corresponding teeth of the lower jaw. The arch being at this point bent inwards, and the alveolar space thereby contracted, the teeth, in order to find a place for themselves, have forced the central incisor forward, and driven its median edge over the labial surface of the adjoining tooth. In this specimen we have an

Fig. 58. (1)



example of irregularity consequent on the teeth, from some cause (probably the retarded ejection of the temporary teeth), taking an improper direction at the time of eruption, the jaw being normal in size: in the preceding case, an illustration of irregularity consequent upon a contracted maxilla.

A slight degree of eversion and separation of the lateral

(1) **Showing the lateral incisor and canine inverted, and the central incisor driven outwards and across the fellow tooth, the alveolar arch at its base being free from contraction.**

from the central tooth at the time when the canine is advancing towards the surface of the gum, is far from uncommon, and when the latter tooth is impeded in its progress by the presence of its temporary predecessor, the disturbance of the lateral incisor becomes still more marked. The following figure shows the effect produced by the foregoing combination of circumstances.

Fig. 59. (1)

When the conical form of the canine and the strongly-prominent convexity of the median side are taken into account, we shall not be at a loss to see how in its descent the root of the lateral incisor is pressed upon, and the crown consequently forced out of position. Instances are not wanting in which the root of this tooth has been more or less absorbed, to make way for the canine; and I have an example in which the fang has been, during development, bent so as to form a hollow, within which the convexity of the canine lay.

(1) Showing the lateral incisor pressed out of the normal position by the canine in its descent to the surface of the gum. The presence of the temporary canine has in this specimen occasioned the permanent tooth to take the oblique direction.

In connexion with mal-position of the canine, a figure will be given, taken from a case in which the lateral incisor has been driven outwards towards the lip, by the canine coming through the gum immediately behind the former tooth (Fig. 61).

The principles which have been laid down for the treatment of the various forms of irregularity in the central, apply equally to the lateral tooth when similarly situated, excepting that the one is, as respects appearance, a less valuable tooth than the other, and may therefore, under certain circumstances, be sacrificed. When, for instance, the lateral teeth are situated as in Fig. 57, we need not hesitate to remove them, supposing the antagonism is normal, and a more forward position of the central teeth would leave a wide interval between the lingual surface of the upper and labial surface of the lower teeth on the mouth being closed. But if the central incisors in such a case passed behind the corresponding teeth of the lower jaw, it would then be our duty to bring them forward, and afterwards force the laterals into the space which would be formed by the previous operation In cases presenting the peculiarities shown in the second figure, the operation is very simple. We have only to bring the inverted tooth, or teeth, outwards, and the antagonising teeth will keep them there.

Supposing the displacement to be caused by the canine when about to take its place in the series, we must wait until the evolution is completed, removing, of course, any temporary tooth which may operate in disturbing its course. If after the eruption of the canine the lateral does not regain the proper position, the usual means must then be adopted

for its restoration. But it may happen that the teeth are driven inwards or outwards, or are twisted by the canines, which, in the absence of sufficient space for their proper evolution, take a position either external or internal to the dental line.

Irregularity in the position of the canine teeth.—Of all the teeth, none are so frequently out of the normal position at the time of eruption as the canines, and it may be stated without fear of contradiction, that no other members of the set so frequently fall from an objectionable into the proper position without mechanical assistance. We constantly see cases in which, at the age of ten or twelve years, these teeth hold a situation somewhat external to the arch formed by the incisors; but if they are watched it will be found that before the eighteenth year has been attained all irregularity has disappeared. It becomes a matter of some moment to ascertain by what process the uniformity of arrangement is attained. So far as my own observations have enabled me to judge, the effect is produced not so much by the canines falling into the pre-existing arch; but as by the lateral and central teeth moving slightly outwards, and adjusting themselves to the position of the more prominent teeth. There are, however, many cases in which the interval between the lateral incisors and the anterior bicuspids is so small that the canines necessarily appear external to the dental arch, and stand so much in front of the lateral teeth that the outward movement of the latter by a natural process is rendered impossible. On referring to the preceding figures, it will be seen that if the outward development of the alveolar ridge is suspended, this position of the canine follows as a necessary result, the

degree of displacement according with the amount of suspension. Then, again, if the normal obliquity is not assumed by the front teeth, a similar condition as respects the canines results. The prolonged retention of the temporary predecessor may also be cited as tending to a like effect.

Although the anterior is by far the more common form of displacement, we not unfrequently see the canine piercing the gum posterior to the dental line, the terminal portion of the root being in this, as in all the forms of irregularity hitherto considered, in the normal position as respects the base of the alveolar ridge.

In determining upon the method of treatment, we must be guided by the principles laid down in respect to the treatment of similar forms of irregularity occurring in other teeth. Whether the involved tooth is external or internal to the dental line, either the arch must be expanded or a tooth must be removed, before sufficient space can be gained for its admission to uniformity. We have the alternative of pressing outwards the neighbouring teeth or sacrificing a tooth.

The canine is the most durable member of the whole series, hence it must, if possible, be brought into place. But circumstances arise under which its extraction becomes expedient. If, for instance, the tooth pierces the gum considerably above the alveolar margin, and is directed outwards, and the interval between the lateral and first bicuspid but slight, we shall then do well to remove it. Teeth so situated being very frequently short, and curved in their roots, are consequently incapable of taking their proper place in the series. A case presented itself only a few days since in which the right canine was so placed. On removal, the root was

found to be short and curved. Had an attempt been made to bring it into line, the apex of the root would have been forced through the labial surface of the gum, and the crown would have stood at a higher level than the corresponding parts of the neighbouring teeth. To have sacrificed the lateral or the bicuspid for this defectively-developed tooth, would have been an obvious error; and to have forced the anterior teeth outwards would have been equivalent to producing a deformity in the whole in order to meet that which had arisen in one of the front teeth.

When we have reason to suppose that an out or instanding canine is not in any way defective, yet the space accorded to it is insufficient, and the anterior teeth, as respects the teeth of the opposite jaw, are well-placed, it becomes a question which of the neighbouring teeth should be removed. The selection must be made in reference to the condition of the adjoining teeth. Should either the first permanent molar, or either of the bicuspids, or even the lateral incisor, be carious, we shall have no difficulty in making our choice; and should more than one of these teeth be diseased, we should then select for removal that one which is nearest to the canine. But if all the teeth are sound, we may then sacrifice that which is the most liable to become diseased. It has been shown that the first permanent molar exhibits the greatest tendency to disease; thus, under the age of fifteen, the respective liability to loss from caries runs in the following order:—Lateral incisors, $3\frac{1}{2}$ per cent.; first bicuspids, 7 per cent.; second bicuspids, $8\frac{3}{4}$ per cent.; first permanent molars, $68\frac{1}{4}$ per cent. [1] The statistical facts advanced in the lectures from which

[1] Lectures on Dental Physiology and Surgery.

the foregoing details have been extracted have met with confirmation at the hands of Mr. Underwood, in a paper containing similar statistical results published in the "American Journal of Dental Science."

Supposing, then, a sound tooth must be sacrificed, there can be but little doubt that we shall do wisely in selecting the first permanent molar.

After the condemned tooth has been removed, the next step in our proceeding may be considered. We must determine whether the bicuspids will fall back and allow the canine to take a proper position without mechanical assistance, or whether our assistance will be required. In determining this point, the age of the patient and the degree of irregularity as regards the canine, will form our principal guides.

Should it be determined to bring an outstanding canine into the dental line, either by acting on the tooth itself, or by operating on the neighbouring teeth, as well as upon the canine, the method described as having been successful in turning into place a twisted central incisor will be found effective; or an ivory plate may be used, if the operator regards metallic regulation plates with distrust.

Irregularity in the position of the bicuspids.—It rarely happens that the front teeth are crowded, without the bicuspids to some extent participating in the general irregularity. They are usually situated internally to the normal position, and are instrumental in throwing the canines out of the proper line, or in giving the appearance of undue prominence to those teeth. The bicuspids may be regarded as forming the base of the semicircular dental curve, which, if contracted, necessarily involves either a deviation from the normal figure, as

seen in the V-shaped mouth, or it obliges some of the teeth to take either an external or an internal position.

If the curve described by a perfectly well-arranged set of teeth be examined, it will be found that it approaches a semicircle, including the bicuspids, and that the molars occupy curvilinear lines, diverging slightly as they proceed backwards. The arch admits of division into two parts; the anterior semicircular portion being occupied by the successors of the deciduous teeth, the posterior division by the true molars—teeth which have had no predecessors. Should, therefore, the breadth of the jaw at the junction of the two divisions fall below the proper extent, and the bicuspids of either side consequently approach too near the median line, not only will the front teeth be thrown out of the semicircular curve, but the molar teeth will occupy lines which, although diverging from the starting-points, will nevertheless fail to attain an amount of separation as respects the two sides of the mouth, consistent with a well-developed denture. The case figured at p. 159 illustrates the condition, and indeed shows an indentation in the arch at the points of junction of the molar and bicuspid teeth.

Arrested growth of the jaw at any period prior to the eruption of the permanent teeth, may produce lateral contraction of the dental arch, or the persistence of the temporary teeth may turn the bicuspids inwards. Although not a common cause, cases may be found in which disease in the temporary molars, and subsequent alveolar abscess, have occasioned the displacement of the bicuspids. In the case figured at p. 73, the first bicuspids have been driven outwards by disease about the first temporary molars.

When one only of the two bicuspids is involved, we shall generally find the second bicuspid to be the misplaced tooth. In that case, the mischief may have been produced either by want of sufficient space for a regular arrangement, or from the presence of the whole or a part of its predecessor.

When the former cause has led to the deformity, the degree of displacement will vary in accordance with the amount of contraction of the allotted space. Thus, when the firs bicuspid and first molar are closely approximated, the second bicuspid or premolar commonly comes through the gum internally to the arch.

It is far from uncommon to find the latter tooth, twisted upon its axis by the presence of the lingual root of the second temporary molar, wedged between the first permanent molar and the former tooth. In a succeeding figure (Fig. 63), the second bicuspid is completely turned round, so that the lingual has become the labial surface, and in this case the labial root of the temporary tooth has been retained.

In determining upon the course of treatment, we must be guided in the first place by the condition of the jaw. If the base is contracted, it will be necessary to remove a tooth, but should the teeth be turned inwards, and their outward movement can be effected without deranging the anterior part of the dental arch, we must then adopt a plate, and have recourse to the compressed-wood wedges. Either metal or ivory may be used in constructing the apparatus, and the wedges, if properly proportioned, will serve for its retention without the aid of ligatures or clasps. The movement is very readily effected, but we must not neglect to take into account the antagonism of the opposing teeth; usually the lingual

cusps of the upper close between the outer and inner cusps of the lower teeth, and unless the lower bicuspids are moved outwards cotemporaneously with the upper teeth, the normal antagonism will be destroyed. Moreover, there will be a strong counteracting force exercised by the stationary teeth upon those under operation. If the upper teeth, for example, are moved outwards so that the lingual cusps close on the apices of the labial tubercles of the lower teeth, the other teeth will be kept apart until the lingual cusps of the moved teeth slide down either upon the inner or outer surface of the labial cusps of the lower teeth. In those cases in which we find a faulty antagonism, our treatment becomes more simple. If, for example, an upper tooth closes externally or internally to its antagonist, our operation will be confined to the malplaced tooth, which, so soon as it approaches its proper position, will be carried onwards in the proper direction by the influence exerted by the antagonizing tooth of the lower jaw, in the manner described in connexion with misplaced central and lateral incisors.

Irregularity in the position of the crowns of the permanent molars, without the roots participating in the displacement, is of less frequent occurrence than derangement of the more anterior teeth; still, cases sometimes present themselves in which the normal positions are not maintained. Perhaps the most common form of deviation is that in which the second permanent molar on either side is turned inwards towards the median line of the mouth. In a cast given to me by my friend Mr. Alfred Canton, the three molars are arranged in a triangle, the second being placed internally to the other two molars. In this case, the obvious remedy would be the re-

moval of the mal-placed tooth. In cases where the first molar leans in towards the palate, the position might, I presume, be changed by the persistent use of compressed wood applied in the manner already described; but we rarely find these teeth out of place without the anterior teeth participating in the derangement, in which case the treatment would become very tedious were we to attempt to reduce to order the whole of the teeth situated anterior to the second permanent molar. In an early number of the "American Journal of Dental Science," an apparatus for expanding the whole arch is described and figured. It consisted of a metal plate fitted to the palate, and jointed in the median line. The plate was fitted to the necks of the teeth, against which it was made to press by a spiral spring, the extremities of which were connected to either side of the plate. I have no experience of the value of this method of proceeding, neither have I attempted to change the position of molar teeth by mechanical means. In the vast majority of the cases which have come under my notice, this treatment has been rendered inadmissible by the coincident contraction of the base of the jaw, and in those in which pressure might have been used, not only must the upper teeth have been operated upon, but the corresponding teeth of the lower jaw also, in order to maintain the proper antagonism.

As mal-position of the wisdom-teeth almost invariably involves their removal, whatever may be the position of the roots, the consideration of the whole subject in respect to these teeth will be given in connexion with complete irregularity.

In treating of those cases of irregularity which admit of

mechanical treatment, I have confined the description for the most part to the teeth of the upper jaw, under the impression that it would be unnecessary to give a detailed account of the defects of arrangement in the corresponding organs in the lower maxilla. It may, however, be stated generally, that the forms of irregularity which occur in the upper may also arise in the lower teeth, and that the treatment suitable for the one will be equally fitted for the other. The construction of the plate, whether metal or ivory be used, will of course be modified. We have here to adapt the apparatus to the teeth and the lingual surface of the gums only; excepting in the foregoing particulars, the methods of operation will be precisely similar to those already described. The vertical position of the lower teeth renders the retention of the compress wedges of wood particularly easy, and this advantage is still further increased when the teeth so operated upon are inclined either outwards or inwards. The operations for the adjustment of irregularities of position are, however, less frequently attempted on the lower than the upper jaw, owing to the former being hidden to a great extent by the lip, hence they fail to attract that amount of attention which is given to upper teeth.

Irregularities of the permanent teeth in which both the crowns and the roots are out of the normal position—total or complete displacement of the permanent teeth.—Transposed teeth come under this head, but as they do not admit of restorative treatment, examples illustrative of this form of departure from the normal arrangement may be given at the conclusion of the present division of the subject.

The following illustration (Fig. 61) shows the amount to

which a central incisor may be thrown out of the proper position. Here the cause is sufficiently obvious in the presence

Fig. 60. (1)

of a supernumerary tooth. Cases in which the centrals are completely displaced are, however, comparatively rare. All attempts at treatment would in any such case as that which is figured necessarily be useless, supposing the development of the root to have been advanced. Had the supernumerary tooth been removed as soon as it appeared, the incisor would probably have taken its normal position, although even then the displacement during development might have been too great for the operation to have resulted successfully.

I do not remember to have seen any cases in which a lateral incisor had been totally displaced, excepting when teeth have been transposed; there is, however, no reason to suppose that they are more exempt than the central teeth from this form of irregularity.

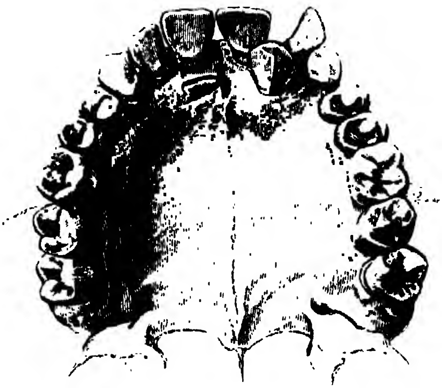
The foregoing observation cannot be applied to the canine teeth. They are more frequently than any other description of teeth the subjects of total displacement. Even in my own

(1) **Shows the right central incisor with both the crown and root displaced, its normal position being occupied by a supernumerary tooth.**

collection there are many examples illustrative of the abnormal positions into which these teeth may be thrown.

Perhaps one of the most common forms of displacement is that in which the canine is situated posterior to the dental line, at a point corresponding to the space which divides the central and lateral incisors. It may happen that the crown only

Fig. 61. (1)



occupies this position, in which case the deformity would admit of remedy; but where the root participates equally with the crown, as in the example which forms the subject of Figure 61, restoration to the normal arrangement, though perhaps not impossible, would be attended with difficulty. The question then arises as to which of the teeth should

(1) Shows the left canine placed behind the dental line, its crown holding a vertical position, and the root, unless greatly curved, equally with the crown, displaced. The lateral incisor has been everted by the canine, while the temporary canine holds the position which should have been occupied by the displaced tooth. The right temporary canine is retained, and the permanent tooth placed horizontally, a portion of the crown only being seen.

be removed. The temporary canine, if left, may endure for some years, but if it be extracted we may be unable to force the permanent tooth into its place, and should we succeed, the crown only would be moved, hence the tooth would hold a slanting and probably unsightly position. My own choice would fall upon the canine. It would, I think, be more easy to press the lateral tooth inwards, the terminal portion of the root of which is not displaced, than to draw outwards into line the canine. In deciding on our treatment, we must in no case lose sight of the fact, that although it may be quite possible to force a tooth from an irregular into a regular position, yet that the operation may, under some circumstances, be so prolonged and painful, that the proposed advantage will not compensate for the suffering which its accomplishment would entail.

Fig. 62. (1)

(1) Shows the right canine placed transversely in the base of the alveolar tract, the crown being directed towards the cheek, and the root towards the median line of the mouth. The bone has been removed to show the course taken by the root of the displaced tooth.

In the preceding figure a case is shown in which the right canine is placed across the dental arch, the root being directed towards the median line of the palate, and the crown towards the cheek. The point of the crown was the only part which was not completely buried in bone. The latter texture has been cut away for the purpose of showing the course taken by the tooth.

An horizontal position in the base of the alveolar ridge is sometimes taken by the canine, the apex of the crown being

Fig. 63. (1)

exposed to view, or covered only by gum or imbedded in bone.

(1) Shows the right canine of the upper jaw buried in the base of the alveolar prominence, its course corresponding with that of the latter part. The bone has been cut away to show the direction taken by the tooth. The first bicuspid has become slightly twisted on its axis by the mal-placed canine. On the left side of the maxilla the second bicuspid has been twisted round until its lingual surface is directed towards the cheek. The presence of the root of the second temporary molar has probably been instrumental in producing this change from the normal position. This case is referred to in a previous page.

Fig. 64. (1)

Fig. 65. (2)

(1) Front view of a specimen in which the canines are placed horizontally in a line corresponding with the base of the alveolar processes. They have been exposed to view by the loss of the teeth and subsequent absorption of the entire part.

(2) Palatal view of the same specimen shown in the preceding figure.

Teeth so placed may remain without producing inconvenience through a long life, and be discovered only towards its close. When with advancing age the teeth fall out, and the alveolar processes disappear, the long hidden teeth are brought to light, and the patient fancies he is cutting a third set of teeth. The two preceding illustrations are taken from a remarkable specimen given to me by Dr. Brinton, in which the canines were symmetrically arranged in the horizontal position described in a preceding case.

Fig. 66. (1)

A patient admitted into the Middlesex Hospital under the care of Mr. De Morgan, lost a portion of the upper maxilla from syphilis. The dead bone on its coming away was found to contain a canine tooth, which ran under the floor of the nose in a direction parallel with the median line of the palate. (Fig. 66.) Excepting the absence of the canine, the dental series was normal.

Although total displacement of the canine teeth is less

(1) **Shows a sequestrum from the upper jaw which became detached during an attack of syphilis. It contains a canine tooth situated horizontally in the floor of the nose, its direction being parallel with the median line of the palate.**

common in the lower than in the upper series, examples of this form of irregularity in the lower jaw are sometimes met with. Of the two specimens selected for illustration, the one

Fig. 67. (1)

in which the tooth is placed horizontally is the more peculiar. In the second, the temporary canines were retained, and the permanent canines became matured within the substance of the jaw. The retention of the temporary may be adduced as the prevailing cause of total displacement of the permanent canine. In several of the preceding illustrations, these members of the temporary set are present. In other cases, however, the arch is fully occupied by the permanent teeth, to the exclusion of the canines, and as these are commonly the last to take their respective places in the series, they are, when so

(1) From a specimen in which the temporary canines were persistent, and the permanent canines placed horizontally. On the left side, a sufficient amount of bone has been removed to show the position of the buried tooth. On the right side the point of the canine may be seen between the lateral and the central incisor. The right temporary lateral incisor has been retained, wedged between the permanent central and lateral teeth.

excluded, liable to be turned completely out of their normal position.

Fig. 68. (1)

The presence of disease, or the occurrence of mechanical injury in that part of the jaw in which the canines are situated when undergoing development, may drive them from their proper position. I cannot, however, call to mind a case which would serve for illustration on this point.

The results entailed by total mal-position of the canines are usually unimportant. Tumours arising in the osseous structure of the jaw have, however, in a few cases, been found to contain a hidden tooth in their centre, and the teeth so placed have been regarded as the cause of the disease. But I am not aware of any case in which a missing tooth has been removed from the interior of a tumour, and the operation been followed by subsidence of the disease. That teeth embedded in the substance of the jaw may become a source of irritation, and predispose to disease in the part in which they

(1) **Shows an inferior maxilla in which the left canine is placed horizontally in the alveolar border anterior to the dental series. The tooth was exposed to the extent shown in the figure.**

are situated, can scarcely be doubted. In the case shown in Fig. 66, it is probable that the presence of the canine not

Fig. 69. (1)

only determined the site of the necrosis, but also the occurrence of the disease, seeing that the loss of the bone was, as regards the alveolar portion of the jaw, limited to the parts immediately around the tooth. During the present year a specimen was exhibited to the members of the Odontological Society, in which a canine tooth lay horizontally on the floor of a large cavity formed in the substance of the lower jaw near its lower border. The history of the case, with the characters presented by the enlargement of the bone, induced the surgeon to excise that portion of the maxilla in which the disease was situated, and it was the excised portion which was shown at the Society.

(1) Shows a lower maxilla in which the temporary (the sockets of which are shown by the dotted lines) were retained, and the permanent canines developed within the substance of the jaw. The bone has been removed on the one side to show the direction taken by the tooth, which has been twisted on its axis to the extent of a quarter of a turn.

Complete irregularity in the position of the bicuspids to the extent shown in some of the preceding figures of misplaced teeth, is of very rare occurrence. In the most strongly pronounced case which has come under my own observation, the root of the second bicuspid of the upper jaw passed backwards between the lingual and labial roots of the first molar. In the case illustrated, the direction of the tooth is much the same as in the foregoing case, although situated in the lower jaw. The first molar had been lost, hence the relations between the roots of that and the displaced bicuspid can only be surmised.

Examples in which a bicuspid stands obliquely across the dental line are not uncommon, but in these the displacement is rarely complete; the extremity of the root is usually in the normal position, and the crown, if there were sufficient space in the dental line, could be brought into the normal position. Now and then, however, a bicuspid may be found with the crown directed towards the tongue, and situated below the alveolar margin. Such a case is figured by Goddard. (1)

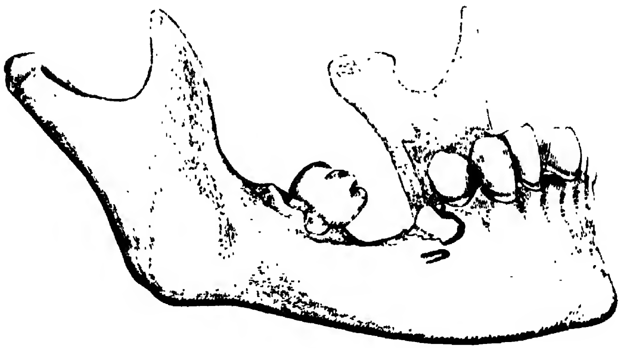
The first permanent molar appearing, as it does, posteriorly to the temporary teeth, at a time when the jaw is in a state of active growth, seldom, if ever, becomes the subject of complete displacement; and I know only of one case in which a fully developed second permanent molar has been found below the alveolar margin. It is figured by Goddard from a preparation in the cabinet of the University of Pennsylvania.

The third molars or wisdom teeth, being the last to take their place in the series, are, from the obstacles opposed to

(1) The Anatomy and Physiology of the Human Teeth. By Paul B. Goddard. Philadelphia, 1844.

their eruption, a frequent cause of suffering, more especially those of the lower jaw. The second molar immediately in front,

Fig. 70. (1)



and the terminal point of the alveolar line behind, bound the space accorded to the wisdom tooth, and if the development of the maxillæ has been arrested, the interval will be insufficient for the normal arrangement of the presenting tooth. It would appear to be the exception rather than the rule for the wisdom teeth, especially of the lower jaw, to take their place among the organs of mastication, without producing some amount of suffering at the time of their eruption, and the degree of inconvenience experienced is often sufficiently great to induce the sufferer to apply for professional assistance. In many of the cases which arise in the lower maxilla the teeth can scarcely be said to be displaced. The deviation from the normal conditions is confined to the jaw itself. The

(1) Shows a lower maxilla in which the right second bicuspid is placed obliquely, the root being directed backwards. The crown, though exposed, does not rise above the level of the alveolar margin.

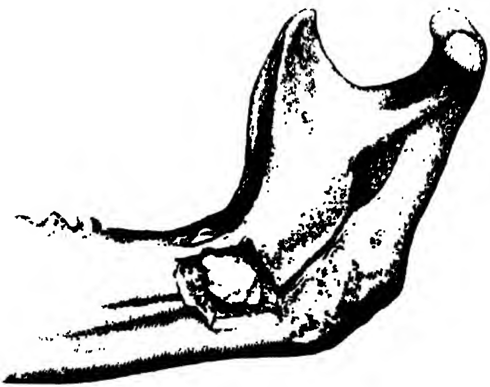
tooth takes its natural direction, but the space into which it has to force itself is insufficient, consequently the distal side lies close against the anterior surface of the coronoid process, leaving no room for the gum. The latter part, under these circumstances is pressed upwards, and lies more or less over the masticating surface of the tooth, and is consequently subject to be bruised from time to time by the tooth or teeth of the upper jaw. In this manner inflammation in the gum is set up and maintained. The disease seldom limits itself to the part injured. It more commonly extends to the adjoining parts, involving the soft textures about the ascending ramus, and extending from thence to the fauces. The act of deglutition becomes painful, and the motions of the jaw are restricted. The patient tells you that it is quite impossible for him to open the mouth sufficiently wide for you to make an examination of the tooth which has occasioned his misery. After a time, the overlying gum suppurates, and the movement of the jaw becomes less constrained.

The patient, however, is extremely cautious in using the teeth, until the inflammatory action has subsided, leaving in some cases the gum in a position to be again wounded by the upper teeth; in other cases leaving the whole of the masticating surface of the tooth perfectly uncovered. If the patient be seen before any great difficulty in opening the mouth has arisen, the tooth may be removed; indeed in all cases where the tooth is wedged tightly between the parts already described, this treatment will be the most judicious we can adopt; for should the gum, after the inflammatory symptoms subside, retreat behind the tooth, still the backward position renders the latter useless as an organ of mastication. And should the gum

retain its unnatural position, the patient will be liable to repeated attacks of inflammation until either the gum-covered tooth or its antagonist has been removed.

There may not, however, be sufficient space between the second molar and the ramus for the wisdom tooth to protrude itself; it then either becomes developed below the alveolar margin, or it comes up partly within the base of the ramus— one half of the crown of the tooth being covered by bone, the other by gum. In either of these cases the patient may or may

Fig. 71. [1]



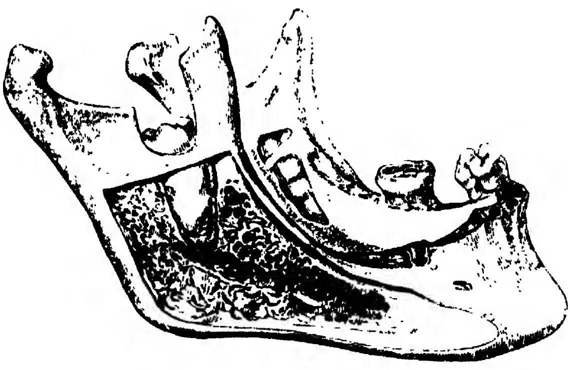
not be subjected to suffering, consequent upon the abnorma position of the tooth; and the absence or presence of mischief will be determined partly by the height to which the tooth rises in the jaw, as respects the antagonistic tooth, and partly by the constitutional state of the patient. The

[1] From a specimen in which the third molar has been developed below the alveolar margin, with the distal side under the base of the ascending ramus of the lower jaw.

same condition of parts which in one person would lead to little or no inconvenience, would in a less healthy subject produce great irritation, and even necrosis ; the extent of the disease varying, again, with the susceptibility of the individual. In any case the involved tooth should be extracted so soon as it is found to be a source of irritation.

In the two preceding forms of deviation from the normal position, the teeth presented themselves in the alveolar line. But cases now and then occur in which, while the vertical position is maintained, the tooth is removed from the alveolar portion of the jaw. In the upper maxilla, it may be situated in the posterior portion of the tuberosity, above the level of the alveoli, and in the lower jaw within the ramus. I am indebted to Mr. Saunders for the use of the specimen which forms the subject of the following illustration. In this example the wisdom tooth on either side is situated high up in the ramus,

Fig. 72. (1)



(1) Showing the wisdom teeth imbedded in the rami of the lower jaw. From the collection of Mr. Saunders.

the crown reaching nearly to the level of the sigmoid notch. Although situated in such an unusual position, judging from the state of the bone it does not appear that they were a source of irritation. There is a total àbsence of that porous condition indicative of increased vascularity in the parts immediately surrounding the teeth. It is probable that during life the presence of the third molar could not have been detected, and in the absence of disease about the jaw, their detection was a matter of no great importance. Still, it is desirable that it should be borne in mind, when disease about the posterior part of the jaws is coincident with the absence of the wisdom teeth from the usual situation, that the lost teeth may lie buried in the substance of the bone, and be the exciting cause of mischief.

In the majority of cases, however, the third molars, when misplaced, lose the vertical position. They commonly take an oblique direction, either forwards, outwards, inwards, or backwards. In the lower jaw, the forward direction is by far the most common form of irregularity, the degree varying from a slightly oblique to a perfectly horizontal direction. The succeeding series of figures show various degrees of this form of misplacement.

In endeavouring to trace the causes which have produced this class of irregularities, we must recognise two distinct conditions. In the one, the tooth, in pressing forwards, has taken the direction in which the least resistance was offered to its progress; in the other the mal-position has been assumed at a comparatively early period of development, irrespective of resistance at the time of eruption. In Figs. 73 and 74, the teeth appear to have advanced until

the median edge or angle of the crowns impinged upon the necks of the anterior molars. The forward movements of the

Fig. 73. (1)

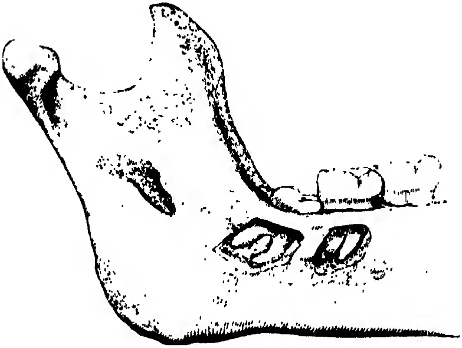
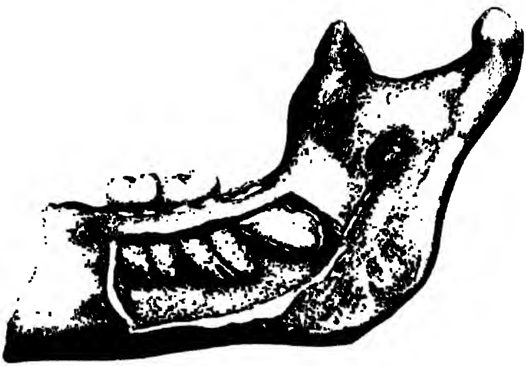


Fig. 74. (2)



(1) View of the inner surface of left side of the lower jaw, the bone being removed to show the oblique direction of the third molar.

(2) View of the right side of the lower jaw, the inner alveolar plate having been partially removed to show the oblique direction of the third molar.

teeth then became completely arrested. In Figs. 75 and 76, the teeth must have been from the first formed pretty much in the position which they are shown to occupy.

Fig. 75. ([1])

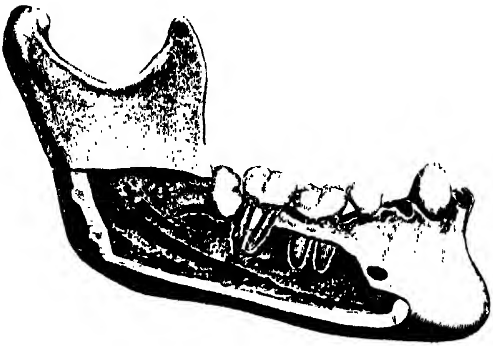
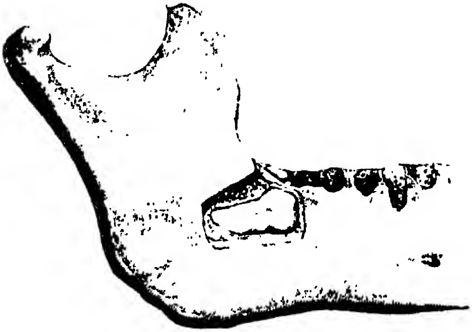


Fig. 76. ([2])



([1]) Showing the outer surface of the lower jaw, with the third molar placed horizontally, the side of the crown of which rises slightly above the level of the alveolar margin.

([2]) Shows a lower jaw in which the wisdom tooth has taken a horizontal position below the level of the alveolar margin.

In the upper wisdom teeth the oblique direction forwards is less frequently assumed. The following figure will, however, illustrate the form of irregularity in the upper maxilla (Fig.77):

Fig. 77. (1)

In the lower jaw it is not common to find the third molar directed obliquely outward, although cases have occurred in which it has assumed that position. In one or two instances I have seen the crown of the tooth buried in the substance of the cheek, and so much obscured by the swelling and inflammation of the soft parts around, that its presence was detected with some difficulty.

In the upper jaw, however, the outward direction is more frequently taken. In the accompanying figure (Fig. 78), taken from a specimen in my own collection, this form of mal-position is shown. A few years since, many practitioners had an opportunity of seeing a case in which the wisdom tooth

(1) **Showing an upper jaw, with the third molar directed forward, and impinging upon the second molar. The small tooth, situated high up in the anterior part of the jaw, was forced there by the spade of the grave-digger. The artist's accuracy in delineating all parts of the specimen has rendered this explanation necessary.**

pierced the cheek. The crown of the tooth was, however, hidden by the whiskers, and appeared to produce no incon-

Fig. 78. (1)

venience. Casts of the cheek, with the projecting tooth, were taken, and I believe one of them may be seen in the museum of the College of Surgeons.

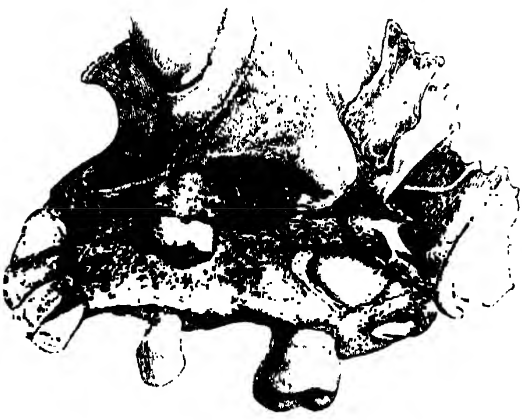
Cases in which the third molar is directed with more or less obliquity inwards, are met with in the lower jaw, but in the upper maxilla they are very unusual. Examples may be found in which the teeth lean slightly towards that direction, but these are not the description of cases under consideration We are now directing attention principally to those deviations from the normal arrangement in which both the crown and the root of the tooth are displaced.

I do not remember to have seen a case in which a lower

(1) Shows the wisdom tooth of the left side of the upper jaw directed outwards.

Fig. 79. (1)

Fig. 80. (2)



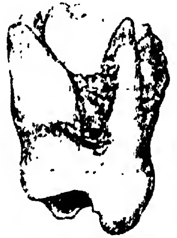
(1) Showing the wisdom tooth of the left side of the upper jaw, with the crown lying against the pterygoid plate of the sphenoid bone.

(2) Shows the wisdom tooth of the right side of the upper jaw placed horizontally, and the crown directed backwards and a little outwards. The bone has been removed to show the position of the tooth.

wisdom tooth assumed the horizontal position, with the crown directed backwards towards the posterior border of the ascending ramus of the inferior maxilla: but of this form of irregularity in the upper jaw I have several examples. In one specimen the crown of the tooth rests against the pterygoid plate of the sphenoid bone; in another, it takes the horizontal position, with the crown directed backwards and a little outwards.

Two cases have come under my notice, in which the direction of the third molars has been completely reversed. The teeth have been upside down. The first example of this rare form of displacement came into my possession with the following history. The patient suffered pain from a carious second molar of the upper jaw. The aching tooth was removed, and with it came the third molar, the fangs of which were interlocked with those of the diseased tooth. The crown and roots of the second held the usual position, but the corresponding parts of the third molar were completely inverted, the well-developed roots of the one embracing those of the other tooth.

Fig. 81. (1)



(1) A second molar of the upper jaw, with the wisdom tooth inverted and embraced within the roots.

There is no reason for supposing that the irregular tooth in this instance produced any inconvenience.

In the second example, the results of mal-position were less fortunate. The presence of the wisdom tooth could not have been detected prior to the operation, either in this or in the preceding case. The following details are taken from my note-book.

A girl of sixteen, the daughter of a tradesman, gave the following history of her case. Nine months since, a swelling appeared in the lower jaw, around the implanted portion of the second molar, and was supposed to be produced by a gum-boil. At first the pain in the enlarged part was but slight and intermittent, but with a gradual increase in the size of the swelling, the amount of discomfort became greater, although it was at no time very severe. I saw her for the first time on the 15th of December, 1856. There was very considerable enlargement of the alveolar portion of the jaw around the second molar. The tooth, however, was perfectly sound, and although slightly tender when pressed upon by the antagonistic teeth, yet it was not considered by the patient to be the seat of pain. The colour of the tooth was perfectly good, and its implantation firm—indeed, there was a total absence of any indications which would induce a belief that disease had arisen, first in it, and subsequently extended to the jaw. The swelling was not confined to the soft parts—the bone was obviously involved. At one point, however, fluctuation could be felt, and the examination did not appear to produce any considerable amount of pain in the part. The absence of active inflammatory symptoms, and the comparative freedom from tenderness, coupled with the large amount of local

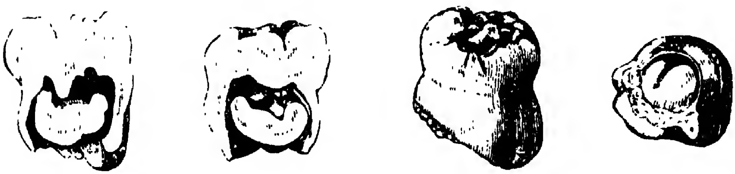
swelling, rendered the nature of the disease very obscure. Mr. Arnott was kind enough to see the case. He introduced a grooved needle, several drachms of clear yellow fluid escaped, and the swelling of the soft parts to a certain extent subsided, leaving the outline of the enlargement of the bone comparatively distinct. The patient felt relieved by the operation from the sense of tension and weight, which had latterly become distressing. I saw her again on the 26th of the following January. The swelling, she stated, had gradually returned, and with it a dull aching pain. The involved tooth I found had in the interval become slightly loose, and was turned a little inwards towards the tongue. The swelling was again punctured, and with results similar to those already described.

On the 5th of February the patient returned. She stated that after the last operation she suffered great pain, accompanied with constant throbbing in the tumour, and that pus had subsequently been discharged from the orifice made by the needle. The amount of constitutional disturbance was sufficient to confine the patient to her room for some days.

On examination, I found that the tooth had become much more displaced than formerly, that it was quite loose, and the surrounding gums were greatly inflamed. Under these circumstances I determined to remove the tooth, although it was by no means clear that it was the primary cause of the mischief. On removal a most curious state of things was manifested. Instead of having the two fangs common to second molars of the lower jaw, the implanted portion of the tooth was dilated into one large concavity, in which was placed the crown of a

second tooth, perfectly invested with well-developed enamel, and with the masticating surface directed towards the jaw. The two teeth appear to be united by dentine at one point, and to have one common pulp-cavity. The appearances presented by the united teeth are shown in the figures.

Fig. 82. (1)



The pain from the operation quickly subsided, and within a fortnight all swelling and pain in the soft parts had disappeared; the enlargement in the bone had also sensibly diminished.

There can be but little doubt that the inverted tooth was the primary source of mischief, and that the strumous diathesis of the patient favoured the development of the disease. But the question as to the manner in which the morbid conditions were developed, remains to be answered. It will be remembered that when treating of the eruption of the temporary teeth, attention was directed to the occasional presence of vesicular enlargements immediately over teeth about to penetrate the gums, and that the contents presented the character of serous fluid or of pus; that a cyst when punctured

(1) **The second right molar of the lower jaw, with the root expanded, and containing the inverted crown of the third molar. The section shows the relations of the pulp-cavity common to the two teeth, and the perfected enamel of the inverted tooth.**

was found to contain the crown of a coming tooth, the enamel of which lay uncovered within the cyst. In connexion with this subject, allusion was made to the fact that when the development of the enamel is completed, its outer surface becomes perfectly detached from the investing soft tissue, and that a slight amount of transparent fluid not uncommonly collects in the interval so formed. Now, I believe we may find in this an explanation, not only of the condition presented by the various stages of the foregoing case, but also an explanation of the manner in which tumours presenting a cystic character, and containing buried teeth, arise.

I conceive that in the case cited, fluid collected between the enamel of the inverted tooth and the remains of the enamel organ, situated within the socket of the second molar. As the cyst enlarged, the contiguous bone was absorbed to make room for it, and new tissue was concurrently developed on the outer walls of the socket, till at last a large cup of bone was formed. The fluid was let out, and re-collected. On the operation being repeated, inflammation and suppuration followed. Here, then, we have a series of conditions very similar to those which have been shown to occur in connexion with a temporary tooth. Differing, however, in situation as respects the jaw, and in the consequences. In the one case the cyst is superficial from the first, and is ultimately obliterated by the coming tooth; in the other it is deep in the jaw, and incapable of obliteration by the eruption of the involved tooth.

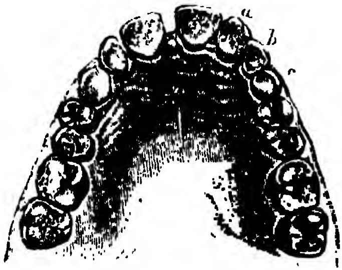
Assuming the foregoing views to be correct, it will not be difficult to see how an encysted tumour of the jaw may be produced by a hidden tooth, a tooth the existence of which cannot with certainty be recognised until the tumour has been

removed. If, for instance, the fluid collects slowly, and the cyst, while undergoing enlargement, becomes constricted by bands of fibrous tissue, we might then have a mass composed of many instead of a single cyst.

In the case alluded to in a previous page, a perfectly sound canine lay at the bottom of a large cavity formed in the lower jaw, near its inferior border. The cavity was evidently lined by membrane, and had been filled by fluid. Now, as neither the bone nor the tooth showed any sign of their tissues being diseased, and as the presence of a tooth in an unusual position does not of necessity lead to disease in the part in which it is placed, the difficulty of accounting for this and for similar cases becomes almost insurmountable, unless we recognise the occurrence of conditions such as those which were observed in connexion with the inverted tooth described in the last page. But the difficulty of explanation is at once overcome if the collecting of fluid to an abnormal amount, between the enamel and the remains of the enamel organ, is admitted as a condition which, under some circumstances, may arise in connexion with teeth, the crowns of which lie within the substance of the jaw. Then again, if, as a consequence of such collection, inflammation be set up, the involved tooth may lose its connexion with the surrounding parts, and in turn become a source of irritation capable of maintaining a morbid condition established in the foregoing manner. Cases of extensive disease about the jaw have been reported, in which, after a considerable lapse of time, a tooth has been removed from an unexpected position, and the patient has then rapidly recovered. Had not the tooth kept up the disease, its removal would not have led to a cure.

Irregularity from transposition of permanent teeth.—In a practical point of view, no great interest is attached to this form of irregularity, as it does not admit of remedy. The succeeding illustration is taken from a case in which the canine is placed between the central and lateral incisor. Sometimes the canine will be found between the bicuspid teeth.

Fig. 83. (1)



The manner in which transposition may arise will be seen if some of the earlier figures are examined. The position of the canine of the upper jaw is, during the period of development, so much above the adjoining teeth, that any irregularity in the growth of the neighbouring parts of the alveolar ridge, or of its contents, may throw it either in front of the lateral or behind the first bicuspid tooth. Even the position of the developing cusp of the canine itself may lead to a similar result. If, for instance, the point be directed either forwards or backwards, the tooth in its

(1) Taken from the cast of a mouth in which the canine (*a*) occupies the place of the lateral incisor (*b*). The temporary canine (*c*) is retained, and placed between the lateral incisor and first bicuspid. In all other respects the series is normal.

descent may lose the proper position, and come either between the incisors, or the first and second bicuspids.

Irregularity in the number of the permanent teeth presents itself as the next subject for consideration. Thirty-two being the number in a normal series of permanent teeth, any deviation, whether it be in an excess or in a diminution of that number, will constitute an irregularity. In other words, there may be irregularity from too many or too few teeth. Each of these forms of departure from the normal series is far from rare; but of the two forms it is perhaps more common to find that in which the teeth are in excess, one or two supernumerary teeth, as they are termed, being present. At all events we will first consider that condition in which the teeth exceed the proper number.

Supernumerary teeth may spring up during the second dentition in any part of the alveolar arch, and the forms of such teeth may either resemble those of special members of the normal series, or they may deviate from each of the recognised forms, and assume a somewhat irregular conical shape, sufficiently characteristic in itself to be at once recognised as that of a supernumerary tooth. (1)

Several cases have come under my own observation in which five equally well-formed incisors occupied the lower jaw. In neither case was it possible to determine from an examination of the crowns of the teeth which was the supplemental tooth. A third lateral incisor in the upper jaw,

(1) Seeing that supernumerary teeth assume two distinct forms, the one being regular the other irregular, it might perhaps be advantageous when speaking of those which in no respect differ from members of the normal series, to use the term supplemental, reserving supernumerary for the irregular-shaped teeth.

undistinguishable from the normal tooth, I have seen in one case only. Instances of a third canine or of a fifth bicuspid, and also of supplemental molar teeth (the form of the additional tooth being perfectly normal), have been seen, though I believe they are extremely rare. But examples in which an ill-shaped tooth without determined form is found placed between the front teeth, or behind them, or even holding the place to the exclusion of the normal member of the set, are met with by all who are engaged in practice. The number is commonly limited to one, or at most two, supernumerary teeth symmetrically arranged; but I have seen a case in which there were four supernumerary teeth, forming a group with the upper incisors and canines. The front part of the mouth looked to be studded over with teeth, without any attempt at a definite arrangement. Indeed, there was some little difficulty in recognising the normal members of the series: for while the supernumerary teeth to some extent resembled normal front teeth, the latter were ill-formed, and approached the former in character. As cases like the foregoing occur from time to time, in which the recognition of the supernumerary tooth or teeth is attended with difficulty, it becomes necessary that we should, if possible, establish the special characters which are peculiar to supernumerary teeth, as distinguished from faulty-shaped normal members of the series. In the absence of such knowledge, we may allow a supernumerary tooth to remain and exclude the normal tooth from its place, as shown in Figure 60; or we may be induced to remove a badly-shaped tooth under the impression that it is not a member of the series.

Yet, where the discrimination depends upon very nice shades of difference, the necessary knowledge, even if it is possessed by the author, can scarcely be conveyed in a written description. Mr. J. Parkinson has placed his collection of supernumerary teeth at my disposal. These, with a considerable number collected by myself, form a series sufficiently large to justify the observer in regarding any peculiarity of form which prevails throughout the collection as a special characteristic of supernumerary teeth. After removing from the series those which are not distinguishable from normal forms, we have remaining, teeth the crowns of which exhibit the following characters:—The lingual and labial surfaces are not distinguished by any difference of form. The enamel terminates on the neck of the tooth in an even line, differing in this respect from the terminal line in ordinary teeth. The crown of the tooth will, in the majority of cases, present a

Fig. 84. (1)

simple cone with a sharp apex; in other instances, the point will be replaced by an irregularly depressed surface, corresponding in character to the masticating surface of a bicuspid or molar. More rarely the conical or cylindrical form

(1) Shows the front view of a specimen in which a supernumerary tooth external to the front teeth occupies the space between the lateral incisor and canine teeth.

is lost, and in its place we have a more or less flattened crown, the grinding surface being marked longitudinally with a deep fissure. Several examples have come under my observation, in which the crown has been divided into three or four plates, meeting at a common centre in such a manner as to produce a cross. It would, however, be hopeless to attempt to describe more than the general characters of supernumerary teeth, inasmuch as the minor differences of form are infinitely varied; no two are precisely similar.

The roots of supernumerary teeth are, I think, almost invariably single. The crown not uncommonly presents a certain amount of complexity, and approaches to the form of a molar tooth, but I do not remember to have seen a single specimen of a strictly speaking supernumerary tooth, in which the root was divided.

The history of supernumerary teeth has not attracted that degree of attention at the hands of practitioners which the subject deserves. There are several points the investigation of which would be attended with advantage. Thus we find that supernumerary teeth for the most part are matured and make their appearance before the permanent teeth situated in the same part of the mouth.

In the case figured at page 183, the position of the central incisor is preoccupied. In the succeeding illustration, a supernumerary tooth holds the place of the lateral incisor, which, with the central, is held back from taking the normal position. In the specimen from Mr. Saunders's collection, two supernumerary teeth (Fig. 87) occupy the place of the central incisors. One of the excluded teeth has come through above the alveolar line.

Again, in Fig. 86 there are two supernumerary teeth, and one of these has to a certain extent interfered with the posi-

Fig. 85. ([1])

Fig. 86. ([2])

tion of the central incisor. Now, in each of these instances the abnormal have preceded the normal teeth, and occasioned

([1]) A palatal view of the specimens shown in Figs. 43 and 44. The supernumerary tooth is situated between the canine and the central incisor of the right side.

([2]) Shows the appearances presented by a cast taken from a mouth in which two supernumerary teeth appeared behind the incisors, one resembling to some extent an incisor, the other altogether irregular in shape.

the malposition of the latter. But it may happen that a supernumerary tooth appears in the place and at the time of a normal tooth, the latter having been retarded in its development by the presence of the former. In one case a central

Fig. 87. (1)

incisor of the upper jaw was cut at the usual time, and by the side of it a supernumerary. The latter was at once removed, under the strong belief that the absent central tooth would after a time make its appearance. The expectation was realized, but three years clapsed first. The neighbourhood of the incisors must be regarded as the most common position for supernumerary teeth to take, and the upper is more frequently favoured than the lower jaw. Instances, however, are not wanting in which the additional teeth appear among the molar division of the series. In a patient of my own, a diminutive tooth, resembling a small and badly-formed wisdom tooth, appeared on each side of the mouth external to the first and second permanent molars of the upper jaw (Fig. 88). The age of the patient and the appearance of the teeth themselves

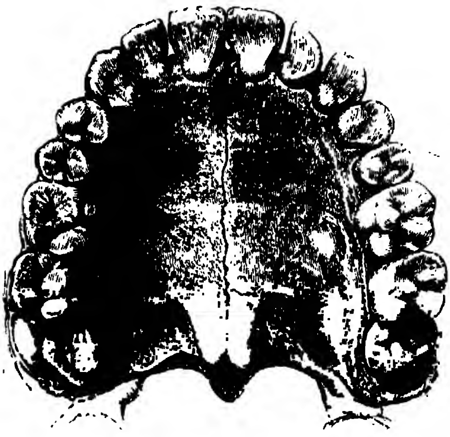
(1) Shows the front view of a specimen in which two supernumerary teeth (*a*) hold the place of the central incisors, while the left central (*b*) has appeared above the alveolar line. I am indebted to Mr. Saunders for the use of this specimen.

led to the supposition that they were the representatives of the wisdom teeth. Within two or three years the eruption

Fig. 88. (1)

of the true wisdom teeth in the usual position showed that the supposition was incorrect.

Fig. 89. (2)



Instances have, however, occurred in which an additional molar tooth has appeared undistinguishable as regards form

(1) Shows a supernumerary tooth placed externally to the first and second permanent molars of the upper jaw.

(2) A palatal view of an upper jaw in which a supernumerary tooth occupies the external portion of the socket of the right wisdom tooth.

from a normal member of the series, and a similar occurrence has been remarked in respect to the bicuspids.

The preceding illustration is taken from a specimen in which a wisdom tooth and a supernumerary occupy the same socket. Although in this case the hard palate is thickened in a peculiar manner, and terminates in four processes, yet the jaw is well formed as respects the dental arch, and the teeth are both well developed and well arranged. In this instance, the form of the jaw can have nothing to do with the development of the additional tooth. Indeed, I do not know that any connexion between the well or ill-development of the jaw, and the occurrence of supernumerary teeth, can be traced. Still, my own personal observations would perhaps justify me in stating that supernumerary teeth are more frequently found in perfectly than in imperfectly-developed jaws.

Fig. 90. (1)

The relations of supernumerary to the temporary teeth during the development of the former, are not in the absence of actual observations readily understood. The growth of the dental pulps of the permanent teeth within the sockets of the temporary has been described, together with the progressive formation of crypts in the inner walls of the sockets for the reception of the pulps. Now, where we have supernumerary teeth in the front part of the mouth taking precedence slightly, in respect to time, of the permanent teeth, a question is suggested as to the relations at the period of early formation

(1) Supernumerary tooth from between the second and third molars of the lower jaw.

of the latter to the temporary teeth, and to the supernumerary. It remains for future anatomists to determine whether supernumerary teeth arise in connexion with the temporary or with the permanent teeth, or whether a normal permanent tooth may arise in connexion with a supernumerary, the one holding the same relations to the other as, under ordinary circumstances, the first and second teeth do to each other.

A single phrase will suffice to describe the treatment of cases in which supernumerary teeth make their appearance. They should be extracted so soon as their character is clearly established.

Instances may, however, occasionally present themselves to the practitioner, in which a supernumerary tooth may be retained with advantage; but these will for the most part be confined to those cases in which, from neglect, the whole of the teeth have been allowed to remain until all chance of the normal tooth coming into its proper position on the removal of the intruder is lost.

In the case shown in Fig. 60, the central incisor would have probably occupied the usual place had the supernumerary tooth been removed on its first appearance through the gum, but had its extraction been performed after the completion both of itself and of the displaced central tooth, no advantage would have been gained by the operation. The position of the central incisor having been unalterably determined, the space left by the extraction of the intruder would have remained unoccupied.

Under the head of irregularity in the number of the permanent teeth, those cases in which the *dental series is more or less defective*, yet remain to be considered.

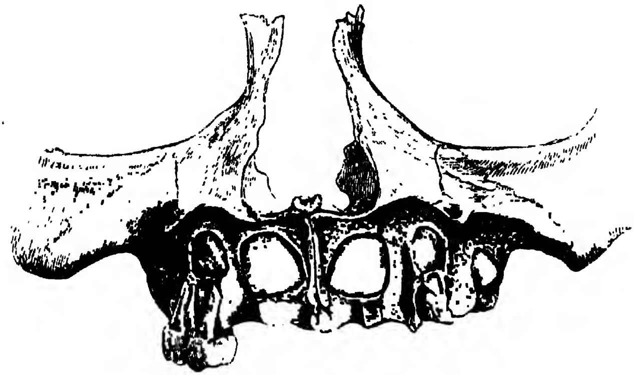
Instances have been cited of a total absence of the permanent teeth. One or two such cases have been described to me by parties who have examined the subjects for themselves. In my own practice, however, I have failed to meet with an individual who from the first was perfectly destitute of permanent teeth. The nearest approach to the edentate condition which has in any way come under my own observation, is exhibited in two casts taken by Mr. Harrison from a patient under his treatment. One molar occupied each side of the upper and lower jaws. These four molar teeth, with four incisors (two in each jaw), were all the permanent teeth.

According to the statements of the patient and of her friends, the temporary teeth presented no peculiarities either as regards their number or the manner or the time of their shedding. A temporary canine tooth was retained in the upper and lower jaw; the other members of the deciduous set dropped out at the usual time, but, with the exception of the four central incisors, their successors were wanting. A case has been already described, in which there was an almost total absence of the temporary series, yet permanent teeth not only made their appearance at the usual time, but took their place with great regularity as respects arrangement. Now, although these two instances may be looked upon as very rare and exceptional ones, yet they prove that temporary do not necessarily precede permanent teeth, and that temporary are not necessarily followed by permanent teeth. With these facts before us, we shall be able to turn to the condition of the temporary teeth in explanation of any diminution in the permanent series, with but very little hope of success.

Although any great diminution in the number of the per-

manent series is rarely seen, the absence of one or two members of the set is far from uncommon. I know several

Fig. 91. (1)



families the members in each of which are destitute of lateral incisors in the upper jaw.

I am indebted to Mr. James Parkinson for a specimen of a young jaw in which both the temporary and permanent lateral incisors are wanting.

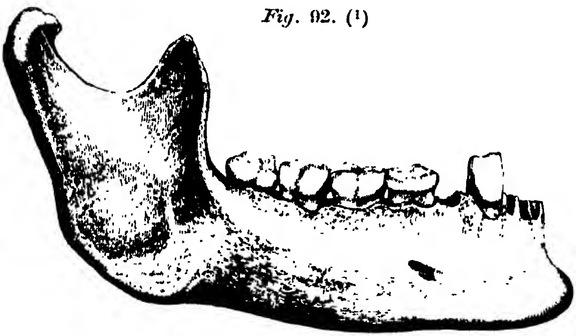
The son and daughter of a gentleman who had no lateral incisors in the upper jaw, each bore the marks of their parentage in respect to the teeth. The son had but one lateral incisor, and that was a very small and imperfectly-developed tooth. The daughter had, however, two lateral incisors. They made their appearance at a very late period, and presented the characters common to supernumerary

(1) Front view of an upper jaw of a young subject. The temporary alveoli show that the temporary lateral incisors were wanting, and the absence of permanent lateral teeth is also shown.

teeth, each tooth being nothing more than a small sharp-pointed cone.

I believe when one description of tooth only is wanting, it will be found that the lateral incisor is the missing member. Perhaps we should except from this rule the wisdom teeth. They, however, are so extremely irregular in all respects, as compared with the other teeth, that we are seldom in a position to declare them absent, although they may not have appeared above the surface of the gums. But if the third molars are less frequently absent than the lateral incisors, they stand next in the order of absentees. The second bicuspid is sometimes absent, and its place supplied, as in the following illustration, by the second temporary molar.

Fig. 92. (1)



In a strictly practical point of view, these cases of deficiency in the number of the second set of teeth have but little interest. By those, however, who pursue dental surgery as a liberal profession, they will not be passed over with indifference,

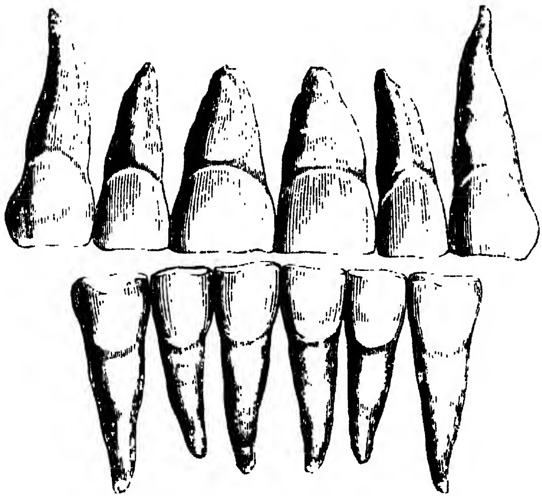
(1) Shows a well-developed adult jaw, in which the second temporary molar is persistent, no second bicuspid having been developed.

although our present knowledge of the subject will not enable us to recognise the cause which has produced the defect.

It is, however, of great practical importance that we should be fully aware that Nature sometimes fails to produce those permanent teeth which are preceded by temporary teeth, and that in such cases the latter will, if allowed to remain, serve the purposes of mastication and articulation up to the middle period of life, and in some instances even later.

Irregularity in the forms of the permanent teeth.—It is not

Fig. 93. (1)



proposed at this place to enter into a minute description of those slight deviations from what may be regarded as the

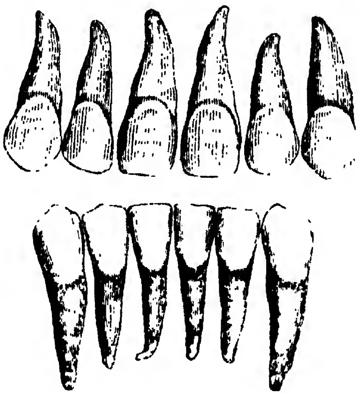
(1) A front view, life size, of an unusually large set of front teeth, of the upper and lower jaws.

typical form of any member of the dental series, but the allotted space will be occupied in considering the more strongly-marked cases of departure from the usual characters.

Teeth, though individually well-shaped, may be so much above or below the ordinary size, that they become disfiguring to the possessor. The two accompanying illustrations (Figs. 93 and 94) are taken life-size from two sets of teeth, the one composed of teeth individually the largest, the other of the smallest, I have ever seen.

In these examples, the peculiarity has been common to all the members of the respective sets of teeth; but

Fig. 94. (1)



we shall sometimes find in the same mouth teeth excessively large associated with teeth excessively small. For example, the central incisors may greatly exceed the average

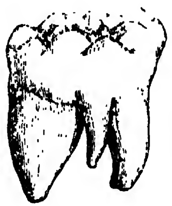
(1) A front view, life size, of an extremely small set of permanent front teeth from the upper and lower jaws.

size, while the lateral teeth are represented by small cones only. Then, again, the corresponding teeth of the same jaw may differ in size and form. The one may be large and well formed, the other small and imperfectly developed.

I am indebted to Mr. Alfred Canton for the very large wisdom-tooth which forms the subject of the next figure, and illustrates the point just mentioned. The tooth is double the usual size, and is the only member of the set which exhibits any peculiarity either as to dimensions or form.

The special form of a member of the series may be altogether lost—so much so, that the mass representing it, unless its history were known, would scarcely be suspected to be a tooth.

Fig. 95. (1)

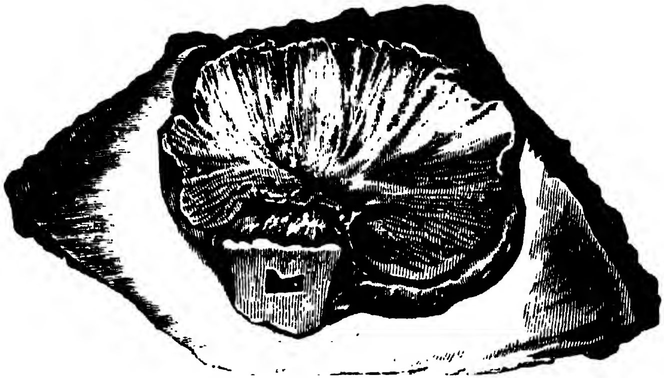


Some years since I had an opportunity of examining a case of this kind. The second molar of the lower jaw was represented by an irregularly flattened mass, composed of enamel, dentine, and cementum, thrown together without any definite arrangement. The wisdom tooth was held down by this most extraordinary tooth. The nature of the case was not rightly understood, consequently a portion of the jaw, including the tooth, was removed. The figure gives the appearance of the

(1) Shows, life size, an unusually large wisdom tooth from the lower jaw.

part after its removal and subsequent division in the longitudinal direction. The dental mass, when removed from its receptacle in the bone, presented no resemblance to a tooth. Little beads of enamel here and there projected from the

Fig. 96. (1)



surface, which was generally rough and irregular. The naked-eye appearance of the section is accurately given in the wood-cut, the radiate character in which shows the arrangement of the component tissues, which by the aid of the microscope are seen at places to alternate. The alternation is mainly effected by the dentine and cementum, and these indeed form the great bulk of the mass. There is a trace only of what

(1) Shows the appearance presented by a vertical section through a portion of the lower jaw in which was enclosed an irregular mass of dental tissues representing the second permanent molar, beneath which the wisdom tooth was confined. The prominence at the lower part of the figure shows the angle, and the part to the left a portion of the ascending ramus of the jaw.

might have been a pulp-cavity, but at no period could the relations which in a normal tooth exist between the pulp-cavity and the dentinal tubes, have been held between the dentinal tubes and any single cavity in the centre of this mass. The component tissues vary in character in different parts; at one point they are well developed, at another confused and irregular. In other situations, again, dentinal tubes radiate from small canals, and become lost in the granular masses and interspaces which lie externally to them. I believe that the appearances presented prior to the operation, consisted in enlargement of the jaw posterior to the first permanent molar, with a hard brown-looking body projecting but slightly from the surface of the gum. This projecting portion was in fact the upper surface of the aberrant tooth; and the nodules of enamel were for the most part situated in this part of the mass. The patient complained of pain in the jaw in the situation of the enlargement, and so the case was looked upon as one of disease of the bone, which would, if left to itself, proceed from bad to worse. The involved

Fig. 97. (1)

portion of the jaw was consequently removed. I believe the case to be quite unique.

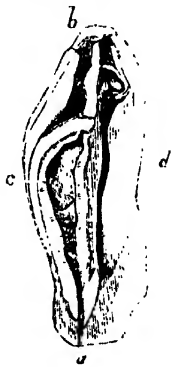
(1) Shows a central incisor of the upper jaw, with an enlargement on the anterior surface, composed of dental tissues imperfectly developed and irregularly arranged.

Examples in which a portion only of a tooth has been deformed by the development of an increased quantity of the dental tissues, aggregated but not arranged in the normal order, have been met with in more than one instance. Mr. Salter has described, in the "Pathological Transactions," a case, under the title of a "warty tooth," which would to some extent answer this description. The preceding figure, taken from a specimen in my own collection, shows a condition of tissues similar to that previously described, excepting that it is here limited to the anterior part instead of involving the whole tooth.

There is yet another form of deformity, in which the arrangement and the development of the dental tissues are defective. The departure from the normal condition is, however, very much less in degree in the character of the case about to be described, than in those which have gone before. The defective tooth, although not necessarily the subject of any very obvious deformity, is usually a little irregular in shape, and at some part slightly enlarged. The enamel investing the crown may be, and often is, perfectly well-developed; but we shall find upon the crown a slight depression, in the centre of which is a small dark spot. If the tooth be divided through its long axis, it will be seen that the dark centre of the depression is in fact the choked-up orifice of a cavity situated within the substance of the tooth, external, however, and perfectly unconnected with the pulp-cavity. If the section be a fortunate one, we shall be able to trace the enamel as it is continued from the exterior of the tooth through the orifice into the cavity, the surface of which is lined more or less perfectly with this tissue. The layer of enamel which forms the surface of the cavity is, however,

thinner, and less perfectly developed than that upon the surface of the tooth, and is in some cases covered here and there with a small amount of cementum. This form of

Fig. 98. (1)



defect, when carried to the extent already described, is perhaps not very commonly met with. I have, however, in my own collection five or six examples. A less degree of a similar fault of formation is very commonly found connected with fissures on the masticating surface of molar teeth of subjects in whom the dental tissues have been but feebly developed. A tooth may to the naked eye appear to be good, but should these unseen imperfections prevail, caries will attack the faulty spots, and if uninterrupted, speedily destroy the tooth. These structural points will, however, come under consideration in connexion with the subject of caries.

(1) Shows a section of an upper tooth in which a cavity (*c*) is formed external to the pulp-cavity (*b*, *d*). It is lined with a thin layer of somewhat imperfectly developed enamel, and communicates with the surface of the tooth at *a*.

Deep fissures are in some cases formed upon the lingual surfaces of the incisors near their bases. A basal ridge of enamel is raised up to a considerable height, and in becoming continuous with the sides of the tooth, leaves a central depression. Now, if this ridge were raised still higher, and the orifice to the cavity so formed contracted, we should have a condition of tooth not very dissimilar to that which has been described.

Hitherto those deformities which are characterized by the presence of an excess, rather than by a diminution, of the dental tissues, have for the most part occupied attention. Irregularity of form is, however, sometimes connected with the latter condition; one tooth may be unusually small and ill-shaped, while the other members of the set are well developed. A case came under my treatment about four years since, in which one of the upper central teeth was irregular in shape, and about one-fourth the size of the corresponding tooth. (Fig. 99.) From some cause, the diminutive incisor occasioned a good deal of irritation in the gum; this, with the unsightly character of the tooth itself, led to its being extracted. The teeth adjoining the vacated space were, by means of ligatures, gradually brought towards each other, and eventually so far reduced the interval, that the absence of the faulty central was not missed.

The irregularity as regards size will sometimes be limited to the root of a tooth. In the example from which the following illustration was taken, the crown has attained the usual size; the enamel, however, exhibits indications of defective organization, and the root is most imperfectly developed. The tooth was removed within two years of its

appearance, in consequence of the irritation it excited in the surrounding gum (Fig. 100). It can scarcely be supposed that

Fig. 99. (1)

Fig. 100. (2)

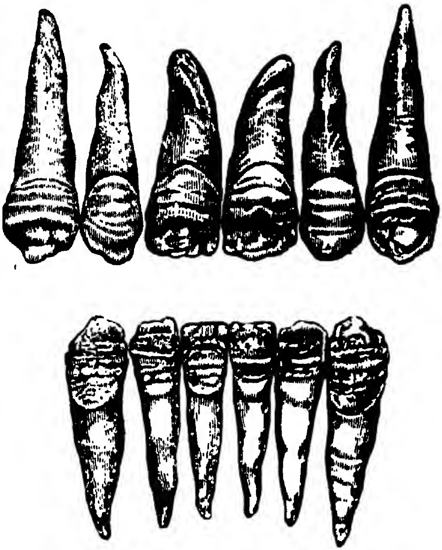
any constitutional condition would cause the production of one defective tooth, and leave uninfluenced other teeth developing at the same time. A strictly local cause may be looked for with much greater chance of success. The prolonged existence of gum-boil in connexion with a temporary tooth may produce the result, or the encroachment of a neighbouring tooth upon the formative pulp may lead to the formation of a dwarfed and misshapen tooth (Fig. 27).

Perhaps we shall not find a more fitting place for considering those deviations from the normal forms of the teeth which are consequent upon interrupted development of the dental tissues. The crowns of the affected teeth, instead of presenting the beautiful smooth and glossy surface characteristic of finely-developed enamel, are disfigured by the presence of an irregularly grooved or pitted surface, accompanied by a considerable diminution in size. The incisors are commonly very thin and compressed, while the canines and the cusps of the molars are terminated by sharp points. By the aid of the microscope we may learn that the tissues are not only deficient in quantity, but that they are defective

(1) Deformed and stunted central incisor of the upper jaw.
(2) Bicuspid of the upper jaw, with the fang imperfectly developed.

also in quality. Neither the enamel nor dentine is perfectly developed; the elements of the former are imperfectly com-

Fig. 101. (1)



bined, hence the tissue is porous, yellow, opaque, and very fragile, and in the latter, the dentinal tubes are wanting in that uniformity of size and arrangement which they exhibit in well-developed teeth.

The condition of system which operates so unfavourably upon the developing teeth frequently passes off before they are perfected; consequently those parts of the teeth which

(1) **Showing the front teeth, grooved from the alternation of perfectly and imperfectly developed portions of enamel.**

are formed after the health has improved assume the normal appearances. It is very common to find teeth which show most distinctly that they have been produced under two conditions of system, the one-half of a tooth will be imperfectly, the other perfectly developed. The observation may with equal justice be applied to whole sets of teeth. The whole of the crowns of the central incisors may be altogether imperfect, while a small portion of the lateral teeth will be well formed. In the canine, the good portion of the crown will be larger than the bad, and the second molar will be altogether without any visible defect. Tracing the teeth from front to back, we may see that the defect crops out at a definite point, and that there will be in this respect a strict correspondence in the two sides of the mouth.

The defect of structure will be limited to such portions of the several teeth as were undergoing development at the same time, and consequently under the same constitutional state. If, for instance, we find the one-half of the crowns of the central incisors and first permanent molars imperfect, one-third of the lateral teeth will be in a corresponding condition, while the defect will not extend over more than a fourth of the crowns of the canines. Again, if the extent of the defect be limited to the cutting edges of the central incisors, the lateral incisors may be free from imperfections.

As yet, those cases only have been described in which the dental tissue exhibits over a certain portion of a tooth obvious signs of a defective organization. But we sometimes find teeth which are marked by grooves and ridges, very regularly disposed. The grooves are the results of imperfect, and the ridges of perfect development of the enamel and subjacent dentine.

Although in many it is not in all cases easy to trace this ridged, or pitted, or honeycombed condition of the teeth to the presence of serious indisposition of the patient during the period when the defective portions of the teeth were being developed, it can, however, be scarcely doubted that an imperfect organization of the teeth, if not the result of some special disease, such as measles, influencing the system generally, is yet consequent upon a constitutional condition. The fact, that if one tooth is affected, those parts of other teeth which correspond in respect to the period of formation will present a similar condition, precludes the supposition that the effect has been produced by a merely local cause. The evidence points to a general cause, but it will not uncommonly be very difficult to discover the precise nature of that cause. The parents may tell you that your young patient has been particularly healthy from the time of birth, having at no time suffered from more than a very trifling and short-lived indisposition. On inquiry, you find that the temporary teeth were well developed, lasted their time, and then dropped out. I have a preparation in which the jaws are particularly well grown, and the temporary teeth unusually fine; yet, on removing the bone to show the permanent teeth, it was found that the latter were honeycombed to a great extent. The converse of this is often seen. The temporary teeth may be lost from caries at an early period, and the maxillæ be contracted, and still the permanent teeth may to all appearance be well-shaped and free from structural defects. There is ample evidence to show, that neither the presence of a good nor of a bad set of temporary can be taken as a positive indication that the succeeding permanent teeth will be good; neither will the evidence furnished by the

parent in all cases enable us to account for the presence of the peculiar form of defect in the teeth to which attention has been directed.

But little can be done to improve teeth with faulty organization. We may direct the patient to keep the teeth scrupulously clean, and we may from time to time remove or reduce with a fine file the irregularities of surface. When the defective part is confined to the immediate vicinity of the cutting edge of a tooth, it may in many cases be wholly removed. The teeth will look short, perhaps, after the operation, which should, however, be delayed until the development of the tooth is completed. In many instances I have been able to file off all the faulty tissue from the canine teeth, a considerable portion of it from the lateral incisors, and a little from the central teeth.

Some degree of caution will be needed in using the file. If too much at a time be removed, or if the operation be performed at too early a period, the teeth operated upon will become extremely tender. As a general rule, it is well to delay any attempt to improve the appearance of the defective teeth by filing until the patient is from twelve to eighteen years of age.

The depressions or faults in the enamel must, however, from time to time be carefully examined, and should any indication of caries be discovered, the cavity in which the disease is situated must be filled without delay.

Slight deviations from the usual forms of the crowns of the permanent teeth need not be described, but it is necessary that attention should be drawn to the fact that *supplemental cusps* are sometimes found arising from the necks of teeth, and presenting all the appearances of distinct supernumerary

teeth. I have known a practitioner seize upon such a cusp, believing it, I presume, to be a supernumerary tooth, and drag out not only the cusp, but the incisor from which it arose.

The case from which the following illustration (Fig. 102) is taken occurred in my own practice. A large nodule or cusp

Fig. 102. (1)

Fig. 103. (2)

projected from the neck of the tooth. It was perfectly covered by the gum, so that its presence could not be suspected, until, in passing the forceps up towards the neck of the tooth, some unusual obstruction was felt.

Supplemental cusps only have been spoken of, but we sometimes see a tolerably perfect little tooth growing out, as it were, from the side of another tooth. In Fig. 103 a small tooth is shown connected with the distal side of the second or third lower molar below the termination of the enamel.

Mr. Harrison placed at my disposal a molar, from the lateral surface of the crown of which a minute but well-formed supplemental tooth projects at a right angle.

Under the head of irregularities in the forms of teeth, several

(1) A permanent tooth, with a large nodule of enamel attached to the neck below the point covered by the edge of the gum.

(2) A lower molar, with a small tooth projecting from its side.

physical peculiarities have yet to be considered, for describing which it is difficult to find a more fitting place.

Those deviations from the normal number and arrangement of the roots of teeth which influence dental operations, will be treated of in connexion with the operations themselves. But as the discussion of the subject of irregularities of form generally would include such as are manifested in the roots, as well as those which occur in the crowns of the teeth, the matter cannot be altogether passed over at this place.

The incisors may have their roots crooked or bent, or even twisted in a spiral form, but I have seen only one example in which they were bifid. In that case, a lateral incisor of the upper jaw had a cusp rising up from the base of the crown on its lingual surface, and a small supplemental root held a corresponding position as respects the root of the tooth.

In the upper canine teeth, two or three specimens only have fallen under my notice which have exhibited a tendency to a division of the one large and strong root into two, an actual division being confined to the immediate vicinity of the apex. In the lower teeth bifid roots are more common.

The bicuspid teeth, unlike the front teeth, are very liable to irregularity in the arrangement of the roots. Normally they have but one root, which is laterally compressed in upper teeth, and in the lower teeth also it is to some extent compressed laterally, yet in a much less degree than in the corresponding teeth of the upper jaw. Very commonly, however, we shall find that the flattened single root of the first bicuspid of the upper is replaced by two, and sometimes even by three, well-formed fangs, holding the same relative position as the roots of the upper molar teeth.

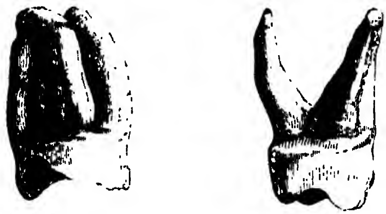
In describing the progressive development of the jaws and the teeth, the necessity for the flattening of the roots of the bicuspids—more especially of the first bicuspid of the upper maxilla—was pointed out. If the figures illustrating that part of the subject be examined, it will be seen that if the upper jaw be contracted, and the canine while still within the bone be brought a little nearer than usual to the second bicuspid, the root of the intervening tooth will almost necessarily become divided. The second bicuspid, owing to its relations during development to the contiguous teeth, is much less liable to a division of its root than the more anterior tooth. Being later to appear than either of its neighbours, the root is not subject to the same disturbing influences as the first bicuspids. Although we may understand how in an exceptional case the one root of a bicuspid may be divided into two, an explanation of the manner in which it is divided into three does not so readily suggest itself. The bicuspids or premolars approaching in character much more nearly to the molar teeth, both in respect to general conformation and to function, might perhaps be expected, when deviating from their characteristic form, to assume that of a true molar.

The bicuspids of the lower jaw, although their fangs may be bent, very seldom terminate by two roots.

Among the molar teeth, the first permanent molars will be found to be the most constant, and the third the least constant, in the number, shape, and position of their roots. Three may be regarded as the typical number of the roots of the upper molar, and two as that of the lower molar teeth. Now, although we find occasional exceptions to these rules in the first permanent molars, they are very occasional. In the

two teeth from the upper jaw which are figured, the three roots are, by the confluence of two, reduced to two in number; and I have seen one or two cases in which the two roots of a

Fig. 104. (1)



first permanent lower molar were united so as to form one conical mass.

On the other hand, in the place of a diminished, we may have irregularity from an increased number of roots. The lower molar may have three, or even four, roots, and the corresponding upper teeth four in the place of three roots. But, as was before stated, these departures from the normal number and arrangement of the roots are very uncommon in the first permanent molars.

In the second permanent molar, however, they are by no means rare, and in the wisdom teeth the typical form is very seldom produced.

No rule can be laid down for the form and number of the roots of the dentes sapientiæ, so variable and inconstant are the forms assumed by these teeth. In one case the tooth is terminated by a single conical root; in another, the one is

(1) Shows two first permanent molars of the upper jaw. In the tooth to the right the two labial roots are united and reduced to one, and in the left-hand figure the posterior labial and the palatal roots are united so as to form one broad and flattened root.

replaced by five, or even six, small roots. The accompanying figure is taken from a wisdom tooth of the upper jaw, the single sharply-pointed fang of which occasioned pain whenever the crown was pressed upon. This, which is life-size, may be compared with the figure of a wisdom tooth given in a pre-

Fig. 105. (1)

vious page (224), in illustration of the sizes between which the third molar may range.

In connexion with irregularities in the number and form of the roots of the teeth, the unusual deviations in the size may be mentioned. The corresponding teeth will vary slightly in almost every instance where a comparison can be made; but in a few cases the departure from the normal length will be greatly in excess of what may be regarded as the average standard. Mr. J. Parkinson gave me a pair of canine teeth which had attained the length of one inch and three-eighths, the roots alone measuring one inch. Excessive length in the root of a tooth cannot be productive of injury to the tooth itself; but the opposite condition — excessive shortness in the root, is often connected with the early loss of the tooth. Instances are sometimes found in which, although the crown of a tooth has acquired the usual size, the root is extremely short and weak; consequently the implan-

(1) **Shows, life size, a wisdom tooth from the upper jaw.**

tation is deficient in that strength and even firmness which is necessary to insure the durability of the organ.

Fig. 106. (1)

In another place, under the head of *Dilaceration*(2), I have described a condition of tooth resulting from displacement of the calcified portion of a tooth from the tissues which were instrumental in its production, the development being continued after the normal position of the calcified part had been lost. Supposing, for example, the crown of an incisor when partly formed be moved from its position upon the pulp, and turned outwards or inwards or to either side, and there to remain in a state of rest, the development of the tooth may then be continued with the displacement of one-half of the crown permanently preserved.

In some cases the amount of distortion will be slight, in others so great and so disfiguring that the tooth is necessarily sacrificed. I have seen specimens in which the crown of an incisor has been placed at a right angle with the root.

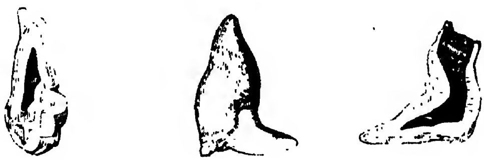
The instances of dilaceration which have fallen within my own notice have been limited to incisors and bicuspid teeth. There is no reason why the molar teeth should not be subject

(1) Showing a central incisor of the upper jaw, the root of which is deficient in size.

(2) Lectures on Dental Physiology and Surgery.

to the deformity equally with the front teeth, excepting that the situation in the mouth of the former renders them less liable to accidental disturbance than the front teeth.

Fig. 107. (1)



To the naked eye the displacement of the crown is sufficiently apparent, but the coincident derangement of the tissues can be seen only by the aid of the microscope. If, however, we take a thin section from a tooth the crown of which has been moved on its pulp during the period of calcification, we shall find the dentinal tubes greatly bent or disturbed in their course at the point of injury. The relations of the enamel, the dentine, and of the cementum, are also interfered with at a corresponding point.

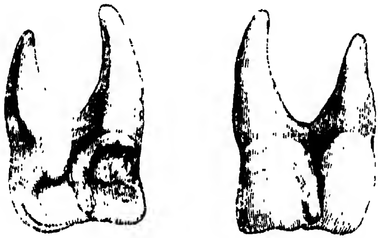
There is one other deviation from the normal condition which, as it affects the forms of individual teeth, must be included under the present heading—viz., *the union or gemination of contiguous teeth.* This subject was entered upon

(1) Shows three instances of dilaceration. The figure to the left is taken from an upper bicuspid, the crown of which had been moved on the pulp. The centre figure is that of a central incisor removed from a boy in consequence of the cutting edge of the tooth being directed towards the tongue. The boy had received a blow upon the mouth. The right-hand figure shows the appearance presented by a section of an incisor similarly deformed to the preceding example, although the development has yet to be completed.

in connexion with the temporary teeth (page 42), but in respect to the permanent teeth it has yet to be considered.

When two teeth are permanently united, the union must have been effected through the medium of their respective pulps prior to the development of the teeth themselves; or the connexion must have resulted from diseased action involving teeth placed in close apposition. Cases of this latter

Fig. 108. (1)



class being the result of exostosis, will be considered in connexion with that disease. In the specimen which forms the subject of the preceding figure, the pulps of the central incisors must not only have come in contact, but have been pressed upon each other with sufficient force to cause the left to have become to a slight extent imbedded in the right tooth-pulp. The development of the united crowns having been perfected, each tooth had its root separately produced.

In a very interesting specimen, for the use of which I am indebted to Mr. Styers, of Nottingham, the central and lateral incisors were united throughout their whole length. The line of confluence, though sufficiently marked for reco-

(1) Shows a view of the lingual and of the labial surfaces of two permanent central incisors of the upper jaw, the crowns of which are united.

gnition, was not deeply cut, consequently the four teeth at a short distance looked like two extremely large but symmetrical central incisors.

Union of the lateral incisor and canine is now and

Fig. 109. (1)

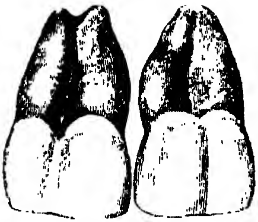


Fig. 110. (2)

then met with. The accompanying figure (Fig. 110) is taken from a specimen in which both the crowns and roots of the lateral incisor and canine are united. The appearance produced by this large tooth was objected to on the part of the parents, who induced a dentist to make an artificial division by means of a file. The operation resulted in opening the pulp-cavity, and consequently in the death of the united teeth. Extensive alveolar abscess followed, for the relief of which I removed the teeth nine days after the operation of filing. In this example, although the union was perfect, and effected by the dentine of each tooth being, at the point of junction, common to the two, yet the position and size of each tooth was defined by a depression running the whole

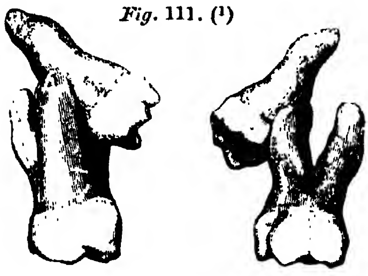
(1) Shows the permanent central and lateral incisors of the upper jaw, united throughout the whole length of the teeth. From a specimen lent to the author by Mr. Styers.

(2) The permanent lateral incisor and canine from the right side of the upper jaw, united.

length of the teeth, and corresponding to the depressed line on the surface, is a contraction in the pulp-cavity which is common to the two teeth. In examining connate teeth, it will sometimes be found that a supernumerary has become united to a normal member of the dental series. Two cases have fallen within my own observation, in each of which a lateral incisor was united to an equally well-developed supplemental lateral. In one example, the teeth had been removed from the upper, in the other the teeth remained in the lower jaw of a patient. In a third case, each central incisor of the upper jaw had joined to its median side a supernumerary tooth, equal to about one half of its own breadth, thus producing by the union two front teeth individually one-third larger than the normal size.

Union between a canine and a bicuspid, or between the two bicuspids, or between a bicuspid and first molar, excepting as the result of diseased action set up long after the

Fig. 111. (1)



development of the teeth has been completed, is of very rare occurrence.

(1) **Shows the second and third molars united. The right figure represents the two teeth from the labial aspect; the left, from the lingual or palatal aspect.**

The molar teeth are not, however, equally exempt from gemination. Many specimens have been preserved showing permanent union between the second and third molars. In the example figured, the third molar passes obliquely between the palatine and posterior labial roots of the second molar, and is united to each of them.

In another specimen, placed at my disposal by Mr. Harrison, the second and third upper molars are united at several points, without the ordinary position in the jaw of either tooth being materially altered. The masticating surface of the wisdom tooth is upon a higher level than that of the second molar; but the difference is not greater than is often seen to exist between the corresponding teeth in the mouths of patients.

In examining a series of connate permanent teeth, it will be found that where the crowns are involved, the union is effected by a continuity both of the dentine and of the enamel, the connecting portions of the tissues being common to the two teeth, and by dentine and cementum, or by cementum only where the union is limited to the roots.

In the one case both the dentinal and enamel pulps were united, and thus produced a geminous tooth; in the other case, the union must have been effected long after the crowns of the teeth were developed, and at the time the roots were forming. In cases of union occurring under the latter circumstances, the medium of connexion may be limited to the cementum, much in the same manner as we see the contiguous roots of a tooth bound together by the interposition of cementum. Those examples in which, by the large development of cementum consequent upon disease, two contiguous

teeth become united, must not be classed with such as may be regarded as cases of congenital union. The cementum may be the uniting medium in either case; but in the one the cementum will not exceed the normal amount, in the other it will exist in excess, and constitute a disease.

Under the head of irregularity of the permanent teeth, one subject only remains for consideration—namely, *Irregularity in the period of their eruption;* the premature or the retarded appearance of members of the permanent set of teeth, and the deviations from the natural order of eruption.

The molar teeth will vary in different individuals as to the time of their eruption, but the amount of variation is seldom sufficient in extent fairly to come under the head of premature eruption. But in those teeth which succeed to members of the deciduous set, a considerable amount of deviation in antecedence of the normal period may sometimes be observed. Before this, however, can occur, the preceding occupant of the space must have been prematurely lost. But in the shedding of the temporary teeth there will be a certain range of variation in respect of time within which the loss of teeth cannot be regarded as premature. The condition of health may hasten or retard the process, and it is probable that hereditary predisposition may also exert an influence in determining the time at which the deciduous teeth fall out, and make room for their successors. In the vast majority of cases, however, the premature loss of temporary teeth depends upon the occurrence of caries, and the consequent extraction of the diseased organs. Many children suffer so much pain from decayed temporary molars, that the general health becomes disturbed, and their removal

is consequently necessitated. Now it is in these cases that the succeeding teeth sometimes appear prematurely, and consequently out of the usual order. A certain number of examples have fallen under my notice, in which one or more of the bicuspid teeth have appeared as early as the lateral incisors; and although in one or two instances the teeth have been imperfectly developed, in other cases all indications of faulty organization have been absent. In a little patient of my own, the whole of the deciduous teeth decayed nearly down to the level of the gum, and produced such serious suffering that the child fell into bad health. At the age of three years and a half the decayed teeth were all removed (excepting the second temporary molars), under the influence of chloroform. The operation was succeeded by a restoration of health, and the permanent teeth are now appearing in the usual order, both as respects the time and the place of their eruption. Now, in this case the premature loss of the first has not been followed by the premature eruption of the second set of teeth. In a less healthy subject the result might have been different; or had the teeth been allowed to remain in this case, and, as stumps, had kept up irritation in the gums, it is more than possible that some of the permanent teeth would have been injured, and have appeared prematurely through an inflamed gum.

In a practical point of view, the accelerated is less interesting than the retarded eruption of teeth. The premature appearance of a tooth cannot be prevented, and when in sight, the mischief it may occasion can be ascertained; but when the eruption of a tooth is delayed, there is great difficulty in learning its relations in respect to the other teeth, its own

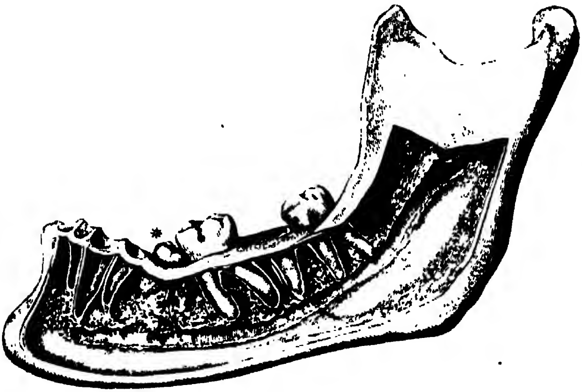
conditions as regards size, shape, and stage of development, and the amount of influence it may exert either in the production or in the maintenance of neuralgic pains.

The irregularities of position, and the results to which they lead, have been already described; hence, in the present section the inquiry may be limited to the question of retarded eruption of teeth which are not irregularly placed during the period of growth; in other words, to teeth irregular only in respect to the period of their eruption. It is by no means uncommon to find that certain members of the permanent do not appear at the usual time, and even after the lapse of some few years are still absent from the usual position, and it is not perhaps until long after their presence has been called in question that they penetrate the gum. In a case which has been described at page 165, the right central incisor of the upper jaw appeared at the age of thirteen, that is six years after the fellow tooth. In a second case, an upper canine pierced the gum at the age of two-and-thirty; and in a third, a similar tooth cut the gum after the patient had passed the age of forty. Again, many cases have occurred in which teeth have been cut at a very advanced age. The recognition of this wide range in respect to the time of the occurrence of a process which is coincident with a known epoch of general growth of the body, suggests an inquiry into the condition of the teeth themselves at the period of eruption, and also into the nature of the process of eruption in these exceptional cases. In reference to the first point, we have to learn whether, when the eruption of a tooth is retarded, the development is equally delayed, and whether the former is consequent upon the latter condition, or whether the one process may be quite inde-

pendent of the other. To meet the second question, two processes by which a tooth may be cut must be recognised. In one, the tooth itself presses forward, and makes its way to the surface; in the other, the gums recede and expose the tooth, which, having been stationary, would have remained in concealment but for the recedence of the gums.

In the cases of retarded eruption of special teeth in which I have had an opportunity of examining the teeth themselves,

Fig. 112. (1)



there has been no evidence to show that the development of the dental tissues had been interrupted. The roots may be shorter than usual, and the crown faulty in respect of form and organization, but the presence of these defects does not prove that the production of the tooth was delayed. Indeed,

(1) Shows the persistence of the second temporary molar retarding the reception of the second bicuspid, which is shown, by the small size of the crypt in which it was contained, to have been stunted and deformed. The temporary tooth is marked by the asterisk. The author is indebted to Mr. Saunders for the use of this specimen.

there is a want of decisive evidence in support of the opinion that the actual development of the teeth is delayed much beyond the usual period, although the numerous cases of late eruption would at first sight favour the supposition. The period of eruption does not, however, in these exceptional cases, bear any necessary relation with the time at which the development of the teeth was completed. In some examples, the obstructing cause is sufficiently obvious, but in others, we fail to see why the tooth did not take its place in the series at the usual time. In the case of a female, the upper canine was absent, a space being left between the first

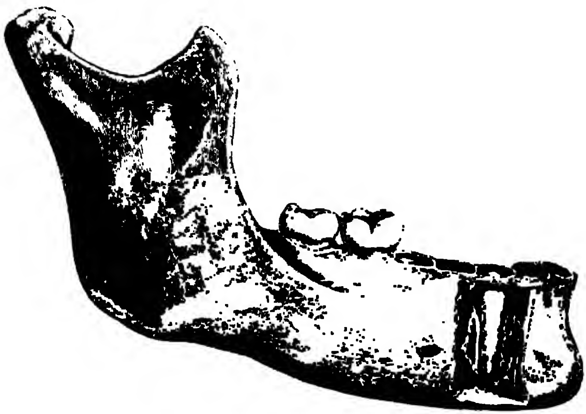
Fig. 113. (1)

bicuspid and lateral incisor. At the age of forty-five, the missing tooth slowly protruded itself. Now, in this instance the way was not prepared by the loss of a tooth, neither were the gums receding; hence we are at a loss to see why the

(1) Showing the first bicuspid retarded in its eruption by the presence of a temporary tooth. The bicuspid is a perfectly well-developed tooth, but the outer wall of the alveolus is absent. The temporary tooth is marked by the asterisk.

eruption of the tooth was delayed, or why it appeared at that age rather than at any other. The case is, however, instruc-

Fig 114. (1)



tive, as respects the process of eruption in retarded teeth. There is no reason for assuming that the development of the tooth was later than of the corresponding tooth which appeared at the usual time; supposing, then, it to be admitted that the tooth was completely developed before the process of cutting commenced, the process itself must be in some respects different from that which occurs when teeth are cut under ordinary circumstances. When the process is normal, as respects the time and the stage of development of the tooth, the crown appears through the gum long before the root has attained its full length. The crown is in great part

(1) An adult lower jaw, with the canine retarded in its eruption. The outer plate of the jaw has been cut away to show the position of the tooth.

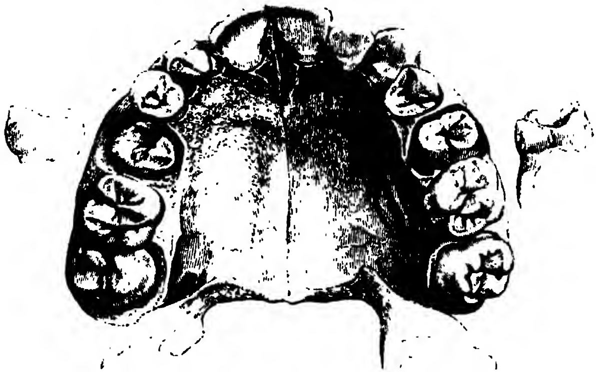
brought towards the surface of the gum by the progressive lengthening of the root, and is afterwards still further raised by the same process. Now, when the eruption is accomplished subsequent to the development of the root, the movement of the tooth must be effected by some other means than by the progressive lengthening of root. The completed tooth has to change its place without itself undergoing any change. The bone which stands in its way must be absorbed, and the lower portion of the socket from which the root of the tooth moves, must be contracted by the deposition of bone. Indeed, in the absence of a better hypothesis, it may be assumed that the gradual contraction of the socket is the means used by nature for bringing teeth to the surface when the process of eruption has been delayed beyond the normal period. In the one case, the movement is effected by the development of bone within the alveolus, in the other, by the progressive development and consequent lengthening of the tooth.

In many cases, however, the retarded teeth become exposed to view by the absorption of the superjacent gum, the teeth themselves being perfectly stationary. The manner in which this takes place, and the effect produced, may be seen on referring to the figures illustrating irregularities in the position of the permanent teeth.

The cause which most commonly retards the cutting of a permanent tooth is strictly a mechanical one. The space which should afford a place for the missing tooth is already occupied either by a persistent deciduous tooth; or by the crowding together of the contiguous permanent teeth. Under these circumstances, the normal occupant of the spot is either held back, as in Fig. 112, &c., or takes some extremely irregular position.

In the accompanying figure, the second bicuspids of the upper jaw were retarded by the presence of the temporary molars.

Fig. 115. (1)



The deciduous tooth on the one side of the mouth had lost all its roots, and there appears no reason why the bicuspid did not take its place at the usual time; but on the other side the temporary molar has retained the greater portion of its palatal root, and was consequently held firmly in place to the exclusion of the bicuspid. Although in this example the usual period for the replacement of the temporary molars has not been exceeded by more than two years, it is not on that account less instructive.

When a temporary tooth does not fall out at the usual time, it becomes a serious question whether we should allow it to remain; whether we should wait until it becomes loose before its removal is attempted, or remove it

(1) **Showing the second bicuspids, at the age of fifteen years, retarded by the presence of the preceding temporary teeth.**

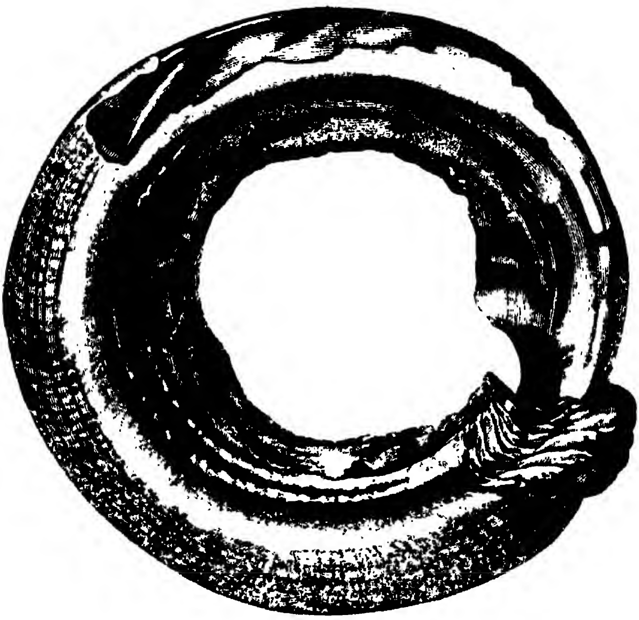
irrespective of this consideration. It is also desirable that the question should in each case be settled before the period of replacement has been long passed by. Now, in the example which forms the subject of the last figure, the bicuspid on the right side has been slightly, perhaps not injuriously retarded by the temporary molar, but the latter tooth would have speedily given place to its successor. Not so, however, on the right side of the mouth. The retention of the palatal root on the part of the deciduous tooth, would have enabled it to hold possession of the position, to the exclusion of the second bicuspid, producing perhaps a similar result to that shown in Fig. 112. But if we resolve upon removing deciduous teeth in all cases when the normal period arrives for their replacement, the practice will now and then lead to disappointment; we may remove a temporary tooth which is destitute of a successor, as shown in Fig. 92, or we may make way for an imperfect tooth, inferior in every respect to its predecessor. These exceptional cases are, however, of such rare occurrence, that although they should not be entirely disregarded, their influence upon our practice should be but comparatively slight. Then, again, the temporary tooth may not only retard the permanent tooth, but it may also lie at a lower level than the adjoining teeth, and consequently if allowed to remain, render little or no service in mastication, as in Fig. 112.

Regarding, then, the persistence of temporary teeth as a cause which commonly operates unfavourably, not only by retarding the eruption of permanent teeth, but also by producing irregularities in the dental series, their removal must, as a general rule, be attended with advantage.

The consecutive changes in the teeth and jaws, which in

the healthy subject keep pace with the general growth of the body, have to some extent been traced; and the results which are entailed when the development of those parts is interfered with have been pointed out; and this brings us to the end of one division of our subject. The section may be concluded by the introduction of the succeeding figure (Fig. 116). The specimen delineated is, I think, unique; a hippopotamus's tusk, the cutting edge of which, from want of antagonism,

Fig. 116.



and the consequent absence of wearing away, gradually advanced until it entered the pulp cavity, and thus put an end to the further development of the tooth.

THE DENTAL TISSUES.

Those abnormal conditions of the teeth and of the dental arch which are the direct consequence of interruption either in the progressive development of the alveolar portions of the maxillæ, or in the eruption of the teeth, have been described under the general head of Teething. We have now to consider the dental tissues in relation to the diseases to which they are subject, and the diseases themselves.

Imperfect structural development, although a predisposing, cannot be regarded as the exciting cause of diseased action. Irregularity, either in the form or the position of teeth, is altogether attributable to a disturbance in the laws presiding over the development of the dental organs; but the destruction of a tooth by caries commences after the tooth takes its place in the alveolar line, and becomes exposed to influences from which it was altogether protected prior to its eruption. The teeth may, and very commonly do, present all the general characters of well-developed organs; yet when examined by the aid of the microscope, exhibit unmistakeable signs of defective organization, rendering them highly susceptible to disease when placed within the influence of conditions capable of exciting morbid action.

On the other hand, those defects of structure which render the tooth liable to early and rapid destruction, may be appa-

rent to the naked eye so soon as the crown of the tooth becomes visible.

Before, therefore, the characteristics of the diseases, and of their predisposing and exciting causes, are entered upon, it will be desirable to give a short sketch of the histological characters of the tissues in which they are situated. It will not be necessary to enter at any greater length either into the development or the structure of the tissues of the teeth than will be strictly subservient to a work on dental surgery. It is presumed that the reader is already acquainted with histology at least so far as the teeth are concerned.

A tooth is composed of enamel, cementum, dentine, and dental pulp.

The relative position of the several structures which collectively form a tooth may be best seen by dividing one of the front teeth longitudinally. Commencing the examination from the surface, we shall find that the crown is encrusted by a layer of enamel, which is comparatively thick over the prominent parts of the masticating surface; but it becomes thinner on the sides, and is eventually lost on the neck of the tooth. At its terminal edge, the enamel is slightly overlapped by the cementum, which holds to the fang and neck of the tooth similar relations, in respect of position, to that which the enamel does to the crown.

The cementum, however, attains its maximum amount of thickness about the terminal portion of the root, and suffers a gradual diminution until it is lost on the neck of the tooth. In a few rare instances it may be traced, not only over the terminal edge of the enamel, but for some little distance upon the coronal portion of the tooth, and specimens are now and

then found in which it fills up the deep fissures situated between the tubercles of the molar teeth. The enamel and the cementum enclose the dentine, the outer surface of which, if the investing tissues were removed, would still present the characteristic form of the tooth with but little alteration, excepting a slight diminution of size.

The great bulk of the tooth is made up of dentine, in the centre of which is found a cavity, bearing a general resemblance in form to that presented by the tooth itself. In the central cavity the pulp of the tooth is contained. In the roots of the teeth the cavity is small, and the pulp is at this point principally composed of nerves and bloodvessels; but as the neck of the tooth is approached, the cavity attains its maximum size, and afterwards diminishes as it assumes the form presented by the coronal surface of the tooth. The pulp cavity communicates with the surface of the tooth by a small opening situated at the end of the root, and through this opening the nerves and vessels enter. In a few specimens, canals for the passage of vessels may be found entering the pulp cavity through the side of the tooth, midway between the neck and the apex of the root; but these must be regarded as exceptional cases.

The Enamel.—It has been usual to consider that the enamel is composed of six-sided parallel fibres, waved in their course, and laterally united. The inner ends of the fibres rest upon, and are united to, the surface of the dentine, and the outer extremities form the surface of the crown of the tooth. In tracing the course of the fibres, it will be found that those situated on the most prominent parts of the crown take a vertical course, while on the sides of the tooth they pursue a

horizontal direction. Every intermediate position between the vertical and horizontal will be seen on examining the enamel as it passes from the cutting edge of an incisor, or the cusp of a molar, down the side of the tooth. The surface of the dentine presenting a more or less conical figure, the enamel fibres in their passage outwards would become separated from each other, unless the fibres gradually enlarged, or unless supplemental fibres were added to fill up the intervals. There is no reason for supposing that the fibres are subject to gradual enlargement, and it is difficult to demonstrate the presence of supplemental fibres, although their presence need not be doubted. The waved course of the fibres, and the consequent difficulty of tracing a series from the surface of the dentine to the surface of the enamel, together with the structural peculiarities of the tissue, render such a demonstration unsatisfactory. If a thin section, in which the fibres are exposed in their length, be examined, it will be found that they are individually marked by transverse lines, or striæ, situated at tolerably regular intervals. These lines do not necessarily coincide in the contiguous fibres throughout the specimen, although they may be continuous over a limited number of fibres in certain parts of the preparation. In a transverse section of the enamel, the fibres are said to present hexagonal ends. I do not find this to be a constant character. They as frequently approach a square, or an irregular circle, as any other form.

If sections taken from a number of teeth be examined, it will be found that the striæ are much more strongly marked in some specimens than in others, and that they are most strongly pronounced in those parts of the specimens which,

when seen by transmitted light, have a brown colour. This, which is an exceptional condition, and limited in extent in well-formed teeth, will be found to pervade the whole of the enamel in the teeth of certain unhealthy subjects. The teeth, in place of the brilliant white and almost translucent appearance, have a dull opaque yellow colour. Enamel having this defect presents structural characters which are much more strongly marked than obtain in that which is more perfectly developed. In it the strongly pronounced structure is under a high power seen to result from the occurrence of minute granular masses occupying the central portion of the fibres, and placed at regular intervals. The masses are comparatively opaque, while the interspaces are transparent, and the alternation of the opaque and transparent parts gives the appearance of striation, and also contributes largely in giving distinctness to the individual fibres.

But the distinctness of these histological characters may be greatly increased by the use of dilute hydrochloric acid. We may, by means of this agent, as it were dissect out the tissue, and demonstrate its component parts. The manner of proceeding is as follows:—After reducing a section of enamel sufficiently thin, place it for two or three seconds in dilute hydrochloric acid (one part of acid to twelve parts of water). Then wash the section, for the purpose of removing the acid, and place it in fluid in the field of the microscope, under a quarter or an eighth-of-an-inch object glass. It will now be seen that the acid has acted upon those fibres which have been cut through in making the section, but not equally on all parts of them. The granular masses will have been removed before the transparent intervals have been materially acted upon.

In those parts of the section where the fibres have been divided transversely, the tissue will resemble a portion of honeycomb from which the honey has been removed, and

Fig. 117. (1)

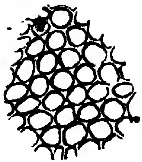
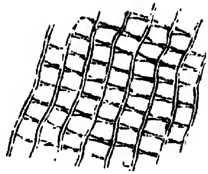


Fig. 118. (2)



where the section is oblique, the comparison will hold if the comb be similarly divided. (Figs. 117 and 118). But where the section is parallel with the direction of the fibres, it will be found that the granular contents have not been removed, excepting in those fibres which are near the surface.

Fig. 119. (3)

(1) A transverse section of the enamel showing the sheaths which contain the granular masses, after the removal of the latter by acid.

(2) A vertical section of enamel similarly treated.

(3) Shows the appearances presented by a vertical section of the ename after it has been exposed for two or three seconds to the action of dilute hydrochloric acid.

In the deeper ones the masses are preserved, and are seen with great distinctness in consequence of the removal of all opacity from the superficial portion of the section. (Fig. 119).

Now, sections treated in this manner afford but little evidence in favour of the supposition that the enamel when fully matured is, strictly speaking, a fibrous structure. A honeycomb, if the cells were filled with a material of greater opacity or density than the wax of which the cells themselves are formed, would not be regarded as fibrous; yet the arrangement of the parts would resemble those of the enamel. It may be urged that the enamel has a fibrous fracture—that it breaks up in the direction of the component fibres. But on careful examination it is seen that the lines of fracture do not run through the longitudinal interspaces, but through the lines of granular masses. If the tissue were strictly fibrous, the individual fibres would be composed of a single series of granular bodies encased in transparent tissue, presenting a very close resemblance to the ultimate fibrillæ of voluntary muscles. In a longitudinal section viewed by uninterrupted transmitted light, the appearances in some specimens strongly favour this supposition. If, however, the same specimen be examined with the central portion of the pencil of transmitted light interrupted in the manner effected in Gillett's condenser, the dark lines which before appeared to mark the junction of the fibres will be resolved into transparent interspaces. The difference seen in the same part of the same preparation when examined under the two conditions of light, may perhaps be referred to the greater refractive power in the intervals than in the lines of granular bodies, and also to

the peculiarity of form of the two parts. But whatever the explanation may be, it can scarcely be doubted that the structure is correctly displayed when the hollow pencil of light is used. The transparent intervals then shown coincide with the cellular arrangement seen in the transverse section of the enamel, whether viewed by means of a hollow or a solid pencil of light. It would be very difficult to account for the arrangement which so exactly resembles that of a honeycomb, on the supposition that we were looking upon the cut end of a series of fibres.(1)

But the conditions which are manifested in perfectly matured normal enamel do not obtain until the development of the tissue is fully accomplished. During the process of formation, the fibrous arrangement is sufficiently distinct, and may readily be demonstrated by the aid of hydrochloric acid. If, for example, a thin section be made from a tooth the crown only of which is undergoing development, and submitted to the action of acid, it will be found that the earthy ingredient disappears, leaving a series of decalcified fibres attached like a fringe to the surface of the dentine. Supposing a preparation of this kind were regarded as showing the ultimate structure of the tissue, we should be at a loss to account for the several appearances presented in the preparations previously described. The manner in which these differences arise may, however, be seen if the enamel be carefully examined during the progressive stages of its development. It

(1) It has long been customary to describe the enamel as being composed of fibres, and the description may still be regarded as correct in certain conditions of the tissues. The term fibre will therefore be used, although the author does not consider it strictly applicable when the tissue is perfectly formed.

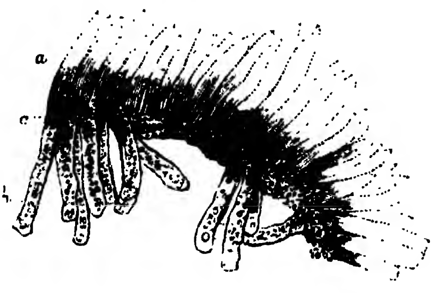
is desirable that the subject should be entered upon, not only for the elucidation of the appearances assumed by enamel when but partially calcified, but also in order that certain structural defects which are the predisposing causes of caries should be understood.

The investigation may be pursued with advantage in the teeth of a seven or nine-months' fœtus. If an incisor be removed from its crypt in the jaw, enclosed within its investing sac, we should, on making a vertical section through the mass (if such a section could be made without disturbing the relative position of the part), find the inner surface of the sac covered over with minute cylindrical columns composed of very delicate tissue, the one extremity of each column being attached to the inner surface of the sac, the other to the surface of the developing enamel.

Such a section cannot be obtained, in consequence of the great hardness of the enamel, even when its calcification is comparatively imperfect. By other means, however, preparations may be gained in which the process of development can be satisfactorily shown. If, for example, a dental sac which has been removed from the fœtal jaw be carefully opened, it will be found that a gelatinous semi-fluid substance is interposed between the inner walls of the sac and the coronal surface of the young tooth. Cylindrical columns, having one or more nuclei, with a certain number of spherical or ovoid nucleated cells bathed in fluid, will be seen to make up this gelatinous matter. Again, if the inner surface of the sac be examined, by removing a small piece and placing it in fluid in the field of the microscope, we shall see that minute columns similar to those found in the gelatinous substance

cover the surface. This is the enamel organ or enamel pulp, from which the columns found in the gelatinous substance have become detached. If we examine the enamel, corresponding columns will be found adherent to its surface. Their presence may also be demonstrated in the following manner. After dividing the dental sac, and turning it back so as to expose the forming tooth, place the preparation in a watch-glass containing dilute hydrochloric acid. In a short time we shall see a membrane-like substance detach itself from the surface of the enamel, which, with a little careful manipulation, may be removed to the microscope for examination, and it will then be seen that one side of the membrane is composed of columns of the enamel pulp, and the other of decalcified enamel fibres, and that the columns and fibres are joined end to end.

Fig. 120. (1)



The columns are, however, very readily detached from the peripheral ends of the enamel fibres, which at this point are laterally united, presenting the appearance of a mem-

(1) Showing the columns of the enamel pulp *b*, connected at *c* with the decalcified enamel fibres at *a*.

brane which not uncommonly assumes a deep brown colour, contrasting with the more internal and colourless portion of the fibres, which, like the columns of the pulp, may become detached. When the columns are detached from the one surface, and the transparent portions of the enamel fibres are removed from the other, we have remaining a membrane which Mr. Huxley has regarded as the membrana preformativa, and as situated between the enamel pulp and the enamel. Mr. Huxley was the first to discover that this membrane could be raised from the enamel at any period of its growth. Up to the time of this discovery it was generally believed that the enamel was formed by the calcification of the columns of the enamel pulp; but if the membrane raised by the acid should prove to be, in the strict sense of the term, a well-defined membrane, separable both from the enamel pulp and the enamel, and not to be a transitional condition of the one in its gradual progress towards becoming the other, then the conversion hypothesis must be relinquished, and we shall fall back upon the opinions held by the older authors; and we must, with Mr. Huxley, regard the enamel organ as exerting no direct influence in the development of the enamel.

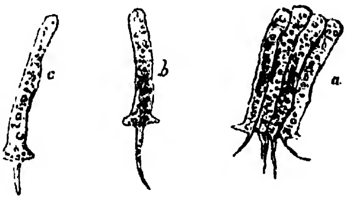
But in a series of investigations made in reference to the elucidation of this point, the results did not coincide with those recorded by Mr. Huxley,(1) and subsequently by M. Lent.(2) The manner of proceeding was similar to that

(1) On the Development of the Teeth, and on the Nature and Import of Nasmyth's 'Persistent Capsule;' by Thomas H. Huxley, F.R.S.—Quarterly Journal of Microscopical Science, No. III., 1853.

(2) Ueber die Entwicklung des Zahnbeins und des Schmelzes, Von Eduart Lent, Stud. Med. aus Hamm. Zeitschrift für Wissenschaftliche Zoologie, Sechster Band, p. 121, 1855.

pursued by the authors cited, and which is described in the preceding page. No difficulty attended the production of the membrane, but the columns of the enamel pulp were found at many points adherent, and their continuity with the fibres could in some cases be distinctly traced, as shown in the preceding figure (Fig. 120). Again, the detached columns adhered in bundles to each other by the ends which approached the enamel, and many of the columns were terminated by delicate processes, which must at the time of separation have been withdrawn from the interior of the partially calcified fibres, and consequently must have passed through the membrane which is supposed to separate the two tissues.

Fig. 121. (1)



Immediately above the point from which the process starts, each column has, when separated from its fellows, a slight circumferential dilatation, as though the cylinder had been everted at the edge when the separation was effected. A close examination of the columns will, I think, lead to the belief that each is composed of a delicate sheath, in which is enclosed one or more nuclei, the interspaces being occupied by transparent granular matter. The nuclei are usually more distinct

(1) Showing the columns of the enamel pulp, with their processes.

near the peripheral end of the columns, the attached extremity being commonly more granular than nucleated; but I have seen cases in which the sheath seemed pretty fully occupied by nuclei. After the preparations have been kept for a few weeks, the nuclei become more faint, and the granular matter more apparent.

Now, supposing the decalcified enamel fibres are detached from the columns and are viewed singly, it will be seen that the ends which approached the dentine are clear and transparent, while those which meet the columns are coarse and granular, appearing by transmitted light of a deep brown colour; indeed, but for the colour, it would be difficult to distinguish the distal extremities of the decalcified enamel fibres from the proximal ends of the columns of the enamel-organs. (Fig. 122.)

Fig. 122. (1)

In many parts of a specimen the columns may be wholly detached, leaving a surface similar to that figured by Mr. Huxley, and described as the membrana preformativa. But if we look directly at the edge of the specimen where it is turned towards the observer, it will be seen that the enamel fibres pass through to the outer surface of this apparent membrane.

(1) Showing the decalcified enamel fibres connected with the granular columns of the enamel organs.

The young enamel fibre, in its decalcified state, consists of a fine transparent and structureless sheath in the part which is fully formed; but in the distal portions, where development is progressing, the sheath appears to contain in many instances granular matter.

In addition to the relations of parts which have been described, it must be remembered that the columns of the enamel pulp are similar in size to the developing enamel fibres, and that the position and direction of the one is that which will be assumed by the other. It is necessary that all these circumstances should be taken into account in estimating the relations which the columns of the pulp hold to the enamel fibres.

Mr. Huxley, who is a great authority in all histological matters, is of opinion that "Neither the capsule nor the 'enamel organ,' which consist of the epithelium of both the papilla and the capsule, contribute *directly* in any way to the development of the dental tissues, though they may indirectly."

This opinion is based upon the fact that by means of an acid capable of dissolving phosphate of lime, a membrane can be raised from the surface of developing enamel. The structural characters of this membrane have already been described. But it may be asked, why is it that we have cohesion at this part when the columns above and the fibres below so readily separate from each other and from the coherent part? This question may perhaps admit of chemical solution. It is possible that this, which divides the calcified and uncalcified parts, has undergone a chemical change preparatory and necessary to calcification,

and that it is thereby rendered cohesive. But whatever may be the explanation, it must not be forgotten that the presence of this so-called membrane can be demonstrated by the means of reagents only, and that a tissue the existence of which can be discovered only by changing the chemical composition of a part, must be looked upon with some doubt.

The preparations in my collection will, I think, fully justify the following conclusions respecting the development of the enamel. That the columns of the enamel organ must be regarded as subservient to the development of the fibres, the conversion of the one into the other taking place in the following manner:—The proximal end of the column becomes calcified, not uniformly throughout its thickness, but the outer surface or sheath first receives the salts of lime, and at the same time the columns become united laterally. At this point—that is, at the extreme margin of calcification—the columns readily separate from the fibres, and leave a surface which, when looked upon directly, has the appearance of a membrane, the reticulate character of which is due to the withdrawal of the central portion of the calcifying column, this central portion being the process which has been described as forming part of the detached column. (Fig. 121.) The calcification of the central part of the column goes on gradually, but does not keep pace with that of the sheath, and when calcified, presents some points of difference when compared with the surface of the fibre. Thus, in adult tissue, the interior of the fibre dissolves before the surface, leaving the reticulated appearance already described. Before calcification, the nuclei of the columns appear to break up into, or become obscured by, subgranular matter, which may often be detected at the distal

ends of the forming enamel fibres. The situation usually occupied by well marked oval nuclei, is the distal extremities of the enamel-organ columns; but sometimes we find examples in which the nuclei, or other bodies like them, fill up the whole of the sheath, and probably become calcified, producing a structure similar to that shown in Fig. 119. That specimen was taken from a tooth the enamel of which was obviously imperfect, and the strongly marked cellular structure must consequently be regarded as exceptional.

Although the fibres of the enamel have attained their full length some time before the tooth is cut, the development of the tissue can scarcely be regarded as matured until after that period; for at the time a tooth passes through the gum, the enamel is comparatively soft and fragile, and it is only after the lapse of some months, or even years, that it attains its full degree of hardness.

Prior to the surface suffering any wear, a membrane can be separated from the surface of the enamel by the employment of an acid. Mr. Nasmyth was the first to draw attention to this fact, and he described the membrane so separated as the persistent dental capsule.

Mr. Huxley considers it to be identical with the membrana preformativa. In several specimens which have been decalcified after being reduced sufficiently thin for microscopic examination, this membrane is obviously continuous with the cementum of the fang; and in other specimens which have not been treated with acid, I find the membrane thickened in the deep depressions of the crowns of molar teeth, and there tenanted by a distinct lacunæ. The occurrence of these two circumstances would indicate that Nasmyth's membrane is

cementum, rather than membrana preformativa. The general absence of lacunæ in this membrane is due to its want of sufficient thickness to contain them, just as we find these bodies wanting in the cementum of the fang when the layer of that tissue is very thin.

Apart, however, from this apparently structureless layer described by Mr. Nasmyth, we may sometimes observe a diminution in the fibrous character of the enamel at the terminations of the fibres on the surface of the tooth, and also at the terminal edge of the enamel on the neck of the tooth. In each of these situations appearances may be found which suggest the idea that a fluid blastema became calcified, and that the fibres had in the process become fused and more or less lost in the mass so formed. Indeed, in the situation last mentioned, lamination of an indistinct character may take the place of fibres; or both the laminated and fibrous arrangement may be replaced by a structure exhibiting little arrangement of parts. In well-developed teeth, however, this deviation from the usual character of enamel is limited to the terminal edge of the tissue.

The preceding observations for the most part relate to the enamel when perfectly formed. We have now to direct our attention to defects in the structural character of the tissue. Faulty organization very frequently leads indirectly to the development of disease; it is therefore desirable that the conditions which characterize the imperfections should be recognised. We may divide them into defects in the quantity and in the quality of the tissue.

The most apparent defect in the enamel is that in which the surface is irregular, either from the presence of numerous pits

or indentations, or of deep transverse grooves, the intervening parts being normal in appearance. In either case the defect may be rather in quantity than in the quality of the tissue, although in the latter respect the organization may also be imperfect. Teeth presenting such characters are commonly spoken of as honeycombed. They frequently want the clear colour and the semi-transparency of healthy organs, for which is substituted a dull yellow appearance, the deeper shades of colour being confined to the depressed portions of the enamel. If a section be made from a tooth which presents these external characters, it will be seen that the surface of the dentine does not necessarily deviate from the usual form, but that irregularity in thickness is confined to the enamel which lies upon it; at one point the dentine will support only a thin and perhaps imperfectly developed layer; at another, a considerable depth of well-formed enamel.

In teeth which are grooved only while the natural colour is maintained, it may be found that the deviation from the normal condition is confined to alternations in the quantity of the tissue, the natural characters, as respects the structure of the enamel, being preserved throughout. But it is frequently seen, that in the deeper portions of the grooves the colour differs from that which obtains in the contiguous healthy structure. In this, as in the case of the honeycombed teeth, the abnormal colour indicates a defect in the structure.

It has been stated, that irregularity in the surface of the enamel does not imply a corresponding irregularity in the surface of the dentine; under ordinary circumstances, the elevations and the depressions on the surface of the crown, have counterparts on the surface of the subjacent dentine, differing

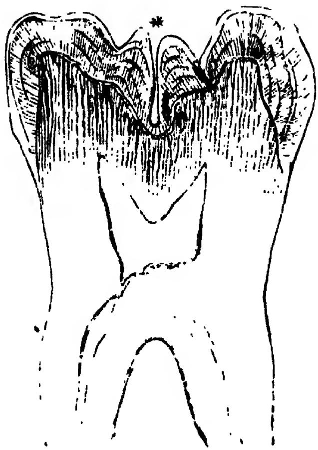
only in the extent of the elevation. The enamel attaining its maximum thickness over those parts of the tooth which are most prominent, consequently breaks the parallelism of the lines formed by the surfaces of the two tissues. Although this is the general rule, many cases will be seen in which the surface of the dentine presents the usual form, while the enamel, from defect of quantity, fails to contribute its share in building up the crown of the tooth; and the cusps of the molars are consequently stunted.

On the other hand, the surface of the dentine may deviate from the natural conformation; the masticating surfaces of the molar teeth may be flattened, or the cusps may be thin and spear-shaped, as though pinched flat, and the incisors may have the same compressed form. In all such cases the enamel will be defective in amount and irregular in its distribution. The same cause which influenced the development of the dentine on the surface of the tooth, will have equally influenced that portion of the enamel which lies in contact with the dentine. Had the formation of the superficial portion of the dentine been normal, the enamel, which is developed upon its surface so soon as that surface is formed to receive it, would have been free from defect, although more external portions formed at a later period might have been defective.

There is another form of defect in quantity. A molar tooth may present to the naked eye all the appearances of a well-developed organ, and yet the enamel may be imperfect, and the imperfection may be in such a form as to ensure the early loss of the tooth. From the natural depressions which separated the cusps of molar teeth, minute but deep fissures may be extended through the enamel to within a short dis-

tance of the dentine, and they may become larger as they recede from the surface of the tooth. In some cases which I have examined, they have been filled with cementum, in others they have been unoccupied till the tooth has been cut, and have then been filled with tartar, but more commonly they become the seat of caries (Fig. 123).

Fig. 123. ([1])



These minute crevices, the existence of which in many teeth an ordinary examination would not lead one to suspect, are constantly met with in connexion with those forms of defective enamel which have been already described.

Independent of the quantity, the quality of the tissue may be defective, and consequently unable to resist the influence

([1]) **Shows a deep fissure in the enamel invisible to the naked eye. The section was taken from a first permanent molar of the lower jaw, removed soon after its eruption.**

of agents calculated to injure the tooth. The account which has been given of the structure and development of the enamel will, though in a histological point of view very imperfect, be sufficient to render intelligible that which has to be said on the subject of imperfection in the organization tissue.

The fibrous character of the enamel, which in the perfect tissue is lost by the blending or fusion of the sheaths of the columns of the enamel-pulp in the process of calcification, may be permanently maintained. Each fibre may to a considerable extent preserve its individuality, a condition which gives an opaque appearance to the tissue, and at the same time greatly impairs its strength. The fibrous character may prevail in certain parts of a tooth, or it may extend through the whole of the enamel. More commonly, however, it will be seen in lines parallel, not with the surface of the enamel or of the dentine, but with the line of growth.

The fusion of the sheaths of the original fibres may, however, be perfect, while the central portions or contents, may have fallen short of perfect development. In the place of faintly-marked striation, we may find either parallel series of well-defined rounded masses, as shown in Fig. 119, or a line of fine granules. Again, minute cavities arranged in single lines may occupy the centres of the fibres, and in some few cases I have seen by the confluence of a series, a tube produced.

The foregoing conditions may be sometimes found in patches amongst the normal tissue of teeth which have the general appearance of being perfectly developed; but when the enamel is obviously imperfect, and presents the honeycombed character, the structural defects will be much more generally diffused.

Not only may the fusion of the sheaths be imperfect, and

the central portions of the fibre fall short of the normal conditions, but even the arrangement of the elements of the tissue be lost. Both the longitudinal and transverse markings may be replaced by a general granular condition, as though the tissue had been formed by the calcification of unarranged spherical masses, about the size of blood-globules, with perhaps here and there a cavity of irregular form interposed.

In the most perfectly developed enamel, the longitudinal and the transverse markings are comparatively faint, and under a high magnifying power with a good light, they appear not as dark but as light lines, enclosing spaces which are occupied by a material which is a little more dense or opaque than that which forms the lines. Any departure from this condition may be justly regarded as a predisposing cause of caries, the degree of predisposition being proportioned to the relative amount of porosity in the tissue. In the foremost rank, as a predisposing cause, must be placed the deep but minute fissures found on the masticating surface of molar teeth; and next in order, the imperfect fusion of the sheaths, and the consequent retention of the fibrous state of the enamel so frequently seen on the sides of teeth.

There are, however, several points connected with the structure of the enamel which have yet to be noticed, but as they are connected equally with the dentine, the structure of the latter tissue may be described before the relations of the two tissues at the point of union are traced.

The Dentine.—If a longitudinal section be made of a central incisor, it will be seen that the surface of the central cavity is everywhere pierced by an infinite number of extremely minute openings. They are the orifices of the dentinal tubes, the

parietes of which are comparatively thick, and, in conjunction with the subgranular matter which cements them together, build up the walls of the pulp-cavity. The tubes take a radiate course from the central axis formed by the pulp-cavity towards the surface of the tooth. In the crown, and also to some extent, though in a less degree, in the root, in addition to numerous secondary minute undulations, the tubes describe several bold curves, which are commonly described as resembling the italic letter *f*. Those situated in the crown differ in some respects from those which occupy the root of the tooth. In each situation the branches which are given off are very numerous, but in the crown there are comparatively few, until the tubes approach the surface encased by the enamel, while in the root branches are given off from the tubes throughout the whole of their course, more abundantly, however, as they near the surface of the dentine. The dentinal tubes by the anastomosis of their branches become connected with each other, and also establish relations with the external dentinal tissues; in the crown of the tooth they terminate by forming loops, or become too minute to be traced, or pass into the enamel and are there lost. In teeth the dentine of which is imperfectly developed, the terminal branches are lost among, or end in, the minute cavities which abound in contour lines at or near the peripheral surface of the dentine. In the neck and root of the tooth, the branches of the tubes anastomose freely, and are lost near the surface of the tissue; near the neck they stop short of the cementum, but towards the end of the root they not uncommonly pass into the cementum, and connect themselves with the lacunæ. By the extension of the dentinal tubes into the

enamel[1] and into the cementum, a connexion is formed more intimate than mere superposition and adhesion of the one to the other would have established, and the more so as the three tissues are developed from three distinct formation pulps.

In respect to the contents of the dentinal tubes,[2] M. Kölliker states, "During life the (dentinal) canals contain a clear fluid, and cannot therefore be readily detected in recent preparations."

In sections which have been dried, the tubes become very distinct, and we may sometimes, on adding a coloured fluid to the preparation when under the microscope, observe the tubes becoming gradually filled.

The foregoing conditions of the dentinal tubes were so easily demonstrated, and appeared to indicate so satisfactorily the offices of these canals, that the subject was regarded as one which had been fully investigated. There are, however, certain physiological phenomena observable in teeth when forming part of the living body, which the recorded knowledge of the histological characters of dentine fails to explain.

If, for instance, a portion of enamel be accidentally broken from the crown of a tooth, so that the dentine becomes exposed, the surface of the latter will be highly sensitive to any variation of temperature from that of the mouth, or to the contact of foreign bodies—even slight pressure from the

(1) In the marsupial animals the uniform extension of the dentinal tubes, not only into but through the greater portion of the whole thickness of the enamel, forms a character sufficiently marked to distinguish the teeth of that from those of any other order of mammals.—On the Structure of the Dental Tissues of the Marsupiata, Philosophical Transactions, Part II., 1849.

(2) Manual of Human Histology, by A. Kölliker. Translated and edited by George Busk, F.R.S., and Thomas Huxley, F.R.S. Vol. ii. p. 41.

tongue will give pain. The degree of pain will not, however, be increased by increasing the pressure. Then, again, in operating upon the teeth for the removal of carious dentine, it is almost invariably found that the dentine immediately below the enamel is much more sensitive than that situated deeper in the tooth.

If the pulp of a tooth be destroyed, either by an instrument or by an escharotic, the sensitiveness of the whole of the dentine is immediately lost, no pain being afterwards experienced when it is cut either near the enamel or the pulp-cavity. The teeth of young subjects are much more sensitive than those of older people, and this is more especially the case when they are attacked by caries.

The dentine of teeth which are rapidly decaying is much more sensitive than that of teeth in which the destruction progresses more slowly. The former condition is indicated by the light colour of the decomposing part, together with the extent of tissue involved; the latter by the deep brown colour, and the comparative hardness of the affected dentine. In certain cases of caries, the even softened tissue appears to be extremely sensitive, so much so that the patient can scarcely bear its removal; but when the instrument reaches the comparatively healthy dentine, the pain, although present, is much less severe.

In any case, however, the dentine loses its power of feeling pain if the pulp be destroyed; but if, after the destruction, the pulp-cavity be perfectly filled with gold, the tooth, in cases suitable for such an operation, may retain its colour and usefulness for a considerable period. The dentine will not, however, recover its sensitiveness.

These several conditions indicate sufficiently clearly that the sensitiveness of the dentine is dependent upon its connexion with the pulp of the tooth, and that it has no inherent sensibility in its own hard tissue, although the tissue may remain for a considerable period without any manifest change, if the root of the tooth be healthy, and the dentine be protected from the influence of the fluids of the mouth.

After a portion of dentine has been for some time exposed, or if the exposure be brought about gradually by the slow wearing away of the enamel, that acute sensitiveness which has been described is not then found to exist. In parts which have been subject to the foregoing conditions, it will on examination be found that the dentinal tubes the peripheral extremities of which have been exposed, are more or less obliterated in some part of their course between the surface and the pulp-cavity.

On reviewing the various circumstances under which dentine evinces sensibility, and those under which that sensibility is lost, it is difficult to avoid the conclusion that the dentinal tubes are in some way the medium through which sensation is distributed through the substance of the tissue. But if the sole office of the tubes be the conveyance of nutrient fluid derived from the pulp, the difficulty of accounting for the sensitiveness of the dentine remains, inasmuch as we have no instance of sensation being manifested in a fluid. We might seem to get out of the difficulty by assuming that the dentinal tubes are constantly filled by fluid, and that pressure made upon the fluid at the exposed ends of the tubes is felt by the pulp at their inner extremities. This assumption does not, however, account for all the circumstances of the case, failing

altogether to explain the greater sensibility of the dentine at one part of the tooth than at another.

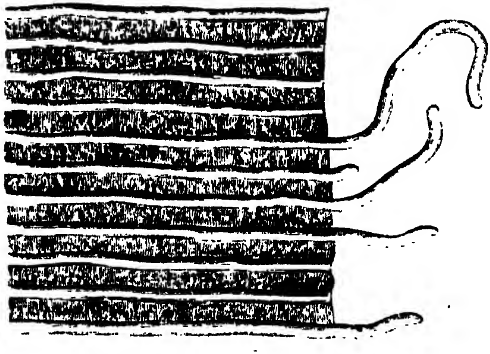
The want of accordance between the views usually entertained upon the structure of dentine and the physiological conditions manifested by that tissue when in connexion with the body, has wholly arisen from assuming that the dentinal tubes are solely for the conveyance of fluid, and that they are otherwise empty. With the hope of gaining some further knowledge upon this point, I commenced a series of observations. I had, however, but little expectation of finding that one of the most important points in dental structure had been overlooked, namely, that each dentinal tube is permanently tenanted by a soft fibril, which, after passing from the pulp into the tube, follows its ramifications.(1)

With proper care in manipulating, nothing is more easy than to demonstrate the existence of the dentinal fibrils in any tooth which has been recently extracted. If a thin section be made in a plane parallel with the direction of the tubes, and then placed in dilute hydrochloric acid until the whole or a greater part of the lime is removed, and the section be afterwards torn in a direction transverse to that of the tubes, many of the fibrils will be seen projecting from the torn edges. (Fig. 124.) It is desirable, in repeating the experiment, to place the decalcified section upon a slide before tearing, as in moving it from the surface upon which it has been torn, some of the longer fibrils may be folded back upon the body of the specimen, and thus become obscured from view. Where the

(1) On the Presence of Fibrils of Soft Tissue in the Dentinal Tubes, by John Tomes, F.R.S., Surgeon-Dentist to the Middlesex Hospital.—Philosophical Transactions, Vol. 146.

separation between the torn surfaces has been but slight, we may often see a fibril, unbroken, stretching across the interval which separates the orifices of the tube to which it belongs.

Fig. 124. (1)



If a section be taken in which the tubes are extended into the enamel, and submitted to the action of acid, it will be found that after the latter tissue has been dissolved, fibrils will remain connected with the dentine at those points where the tubes penetrated the superjacent structure.

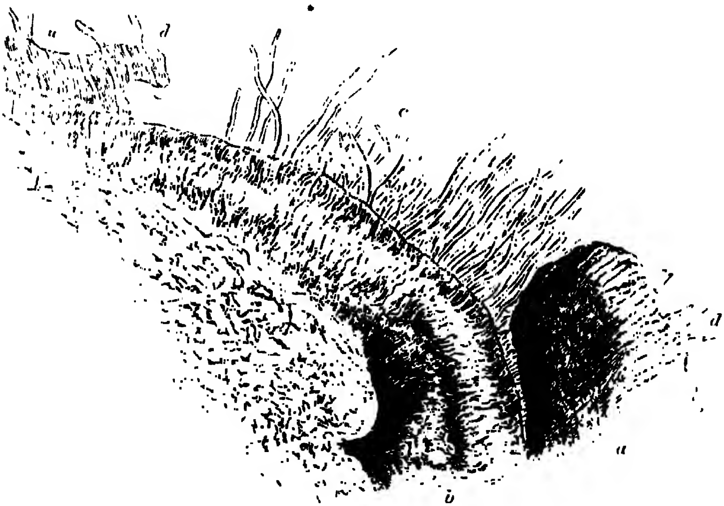
It is not necessary, however, to decalcify dentine in order to show the fibrils. If a similar section to that already described be divided with the edge of a knife, many of these delicate organs will be seen, but they are usually broken off much shorter, many of them scarcely projecting beyond the orifices of the tubes. Again, if a minute portion of dentine be cut with a sharp knife from the surface produced by frac-

(1) A section from the crown of the tooth of an adult, made in a plane with the direction of the dentinal tubes, and afterwards decalcified and then torn in a line transverse to the direction of the tubes. The fibrils are shown extending from the torn edge of the dentine.

turing a perfectly fresh tooth, the same appearances will be seen, but not with the same certainty and distinctness, as in the previous examples.

In order to demonstrate the connexion of the fibrils with the pulp, fine sections should be made with a sharp knife from the edge of the pulp-cavity. In this manner I obtained the specimen from which Mr. De Morgan has been kind enough to draw the accompanying illustration, showing the fibrils stretching from the pulp to the displaced dentine, and some of them passing out on the other side of the fragment. (Fig. 124.) That the fibrils proceed from the pulp may be seen

Fig. 125. (1)



(1) A section made with a knife from the edge of the pulp-cavity of an adult tooth, including a portion of the pulp: (*a*) the dentine; (*b*) the pulp, with the peripheral cells arranged in lines; (*c*) the dentinal fibrils drawn out of the displaced dentine; (*d*) fibrils which pass through the fragment of dentine, and appear on the surface farthest removed from the pulp.

by carefully fracturing a fresh tooth with as little displacement of the fractured parts as possible; and then, by slowly removing the pulp from its place in the tooth, we shall be enabled to examine the fibrils which have been drawn out from the tubes. By this procedure some of the fibrils will be withdrawn from their normal position in the dentine in the greater part of their length, a few of them retaining short lengths of their branches, but sufficiently long to show that they have come from the branches of the dentinal tubes.

Professor Kölliker, in his account of the development of dentine, describes and figures processes extending from the peripheral cells of the dentinal pulp in developing teeth,(1) but he does not recognise the tube-fibril; indeed he, as before cited, describes the tubes as filled with fluid. M. Lent, in a paper published in 1855, gives a similar description to that published by M. Kölliker, and says that the cell-fibres are best seen in teeth which are but little advanced in development.(2) Mr. Huxley states that in a solitary instance he observed a fibre pass a short distance into the dentine.(3)

Both M. Kölliker and M. Lent regard the processes, which they observed extending from the peripheral cells of the pulp in forming teeth, as organisms for the development of the dentinal tubes. The latter author, near the conclusion of his article on the development of dentine, states, *the processes of the cells are the dentinal tubes.* He observes further on, that the fact, first observed by Müller and then by Kölliker, that

(1) Loc. cit.

(2) Zeitschrift für Wissenschaftliche Zoologie, herausgegeben Von C. T. Siebold und A. Kölliker, Sechster Band, 1855, p. 121.

(3) On the Development of the Teeth, and on the Nature and Import of Nasmyth's "Persistent Capsule," by Thomas Huxley, F.R.S.—Quarterly Journal of Microscopical Science, No. 3, 1853.

the dentinal tubules possess separate walls, which can readily be isolated, is explained by the history of the development; the wall of the dentinal canal is identical with the cellular membrane of the ivory cell.

The nature and office of the dentinal fibrils remain for consideration. If a fibril be examined in its natural condition by the aid of an eighth-of-an-inch object-glass, it will be found to consist of an almost structureless tissue, transparent, and of a comparatively low refractive power. In glycerine, the fibrils are scarcely visible. At present it admits of doubt whether they are tubular or solid. In some cases there is an appearance of tubularity; but being cylindrical this may be a mere optical effect. When accidentally stretched between two fragments of dentine, the diameter of the fibril becomes much diminished, and when broken across, a minute globule of transparent but dense fluid may sometimes be seen at the broken end, gathered into a more or less spherical form. These appearances may be explained by assuming that the fibril consists of a sheath containing a semifluid matter, similar to the white fibrillæ of nerves; but whether such a conclusion can be justified admits of doubt. The manner in which the dentinal fibrillæ terminate in the pulp I am at present unable to decide. In favourable specimens they may be traced a short distance into the pulp, but whether they are terminated by cells, or in any way connect themselves with nerves, I am unable to determine. The dimensions of the fibrils are the same as those of the interior of the dentinal tubes.

The conditions under which sensation is manifested in dentine have been already stated, together with those under

which it is lost, and the difficulty felt in accounting for these phenomena has been pointed out. The recognition of the dentinal fibrils will, however, I think, remove that difficulty, and enable the physiologist to explain why, under certain circumstances, dentine is susceptible of pain, while under other conditions the sensitiveness is lost.

That the dentine owes its sensation to the presence of the dentinal fibrils cannot, I think, be readily doubted, seeing that if their connexion with the pulp be cut off by the destruction of the latter, all sensation is at once lost. It is by no means necessary to assume that the dentinal fibrils are actual nerves before allowing them the power of communicating sensation. Many animals are endowed with sensation, which yet possess no demonstrable nervous system; and we may find many points in the human body highly sensitive without our being able to demonstrate the presence of nerves in such numbers as would account for the pain uniformly experienced from the puncture of a needle, upon the supposition that the needle had in each case wounded a nerve. Additional evidence in favour of the view that the fibrils possess sensation may be obtained by examining their condition in diseased teeth, in connexion with the phenomena manifested by the disease. In those cases in which the fibrils are consolidated in the manner which will be hereafter described, there is perfect absence of pain when the affected part is cut into, but so soon as the instrument reaches the healthy dentine, more or less inconvenience is felt. If, on the other hand, there is no consolidation of the fibrils, but the pulp is yet living, the operation of removing the carious part is productive of pain, even from the commencement; indeed,

pressure upon the surface of the softened tissue gives rise to discomfort. If in such cases the softened dentine be examined, fibrils may here and there be found but little altered from their natural appearance.

The greater degree of sensitiveness observable in the dentine immediately below the enamel—that is, at the point of ultimate distribution of the dentinal tubes, and consequently of the fibrils—may be fully accounted for on the supposition that the latter are organs of sensation, and subject to the same laws as nerves of sensation, the highest sensibility of which is confined to their terminal branches.

The recognition of the dentinal fibrils must lead to a modification of the opinions hitherto entertained as regards the office of the tubes, namely, that they are for the circulation of fluids only. The presence of soft tissue would not, however, hinder the slow passage of fluids; and that fluids do pass through or by the side of the fibrils is rendered probable by the fact, that the latter are capable of undergoing structural change at the parts furthest removed from the pulp. When the fibrils become calcified near the surface of the dentine, the hardening material must have been derived from the pulp, at least when the consolidation has taken place in the crown of the tooth.

The foregoing statements of facts will, I think, warrant the conclusion, that the dentinal fibrils are subservient not only to sensation in the dentine, but that they are also the channels by which nutrition is carried to that tissue; and that, like other organized tissues, they may become the seat of morbid action.

In connexion with the structure of dentine, several conditions might be described as characteristic of faulty development of the tissue, but it will be better that an account of the imperfect formations should be postponed until the development of dentine in its normal form has been to some extent described.

Few subjects have engaged the attention of histologists more frequently, and the study of no one has led to more varied conclusions, than the development of dentine. At present two sets of opinions prevail, and they are so distinct and different from each other that one or other must be wholly wrong.

Among the recent authors we have Mr. Huxley, who maintains that the dentinal pulp has no direct influence in the formation of the dentine; while Kölliker, on the other hand, describes a layer of cells which form the peripheral portion of the pulp, and are concerned directly in the formation of the dentine. To the latter we are indebted not only for one of the most recent, but also for the most elaborate account of the development of this tissue. He states that—"The dental sacs consist of connective tissue, in which vessels and nerves are distributed; from their base proceeds the *dental pulp*, which in form resembles the tooth to which it belongs, and consists of an internal portion rich in vessels, and eventually in nerves also, and of a non-vascular external portion. The latter is bounded by a delicate structureless membrane, the *membrana preformativa* (Raschkow), which has no further relation to the development of the tooth. Beneath this lie cells of 0·016 to 0·024''' in length, and 0·002 to 0·0045 in breadth, with very beautiful vesicular nuclei, and

distinct single or multiple nucleoli; they are arranged close together over the whole surface of the pulp, like an epithelium, though not so sharply defined internally as it would be, but gradually passing, at least apparently, by smaller cells into the parenchyma. In vascular pulps an additional boundary line may be traced, inasmuch as the capillary loops in which the vessels terminate do not penetrate between the cylindrical cells, but end close to one another upon their inner surface; so that, considering that the dentine is produced by the cells in question, we might be justified in terming them the *dentinal membrane*, or *membrana eboris*. The internal portions of the pulp consist throughout of an originally granular or homogeneous, afterwards more fibrous, matrix, containing many-rounded or elongated nuclei, which must be regarded as a sort of connective tissue. Vessels are developed in great numbers in the pulp at the period when ossification commences; the most numerous perpendicular loops of capillaries, of about 0·006‴, existing in contiguity with the ossifying surface. The nerves accompany the vessels, but are developed later; their number is very considerable, and their distribution resembles that in the pulp of the perfect tooth. . . . In the development of the dentine, as in that of the enamel, it is not the whole pulp which shares in the process, but only its most external epithelium-like layer of cells, which appear to maintain a constant thickness by the elongation of the original cells, accompanied by a continual multiplication of their nuclei.(1) . . . I by no means intend to assert that one and the same cell suffices for the whole duration of the development of the dentine, although

(1) Mikr. Anat. ii. 2, pp. 103 *et seq.*

this is not inconceivable; indeed I consider it possible that the dentinal cells are from time to time replaced by others, which are formed upon their inner surface; but what I deny is, that the whole pulp is simply changed progressively from without inwards into dentinal cells, and ossified; and I am of opinion that, like the spongy tissue of the enamel organ, the only import of the pulp in the development of the dentine is support to the vessels which are necessary to enable the dentinal cells to grow at all. . . .

"The diminution of the pulp, therefore, is readily intelligible without supposing it to be ossified from without inwards; it takes place, like the diminution of the contents of the wide Haversian canals of fœtal bones, when the lamellæ are deposited upon their walls, by a gradual resorption of its tissue, which, as in the latter case, is soft and full of juices; and it is by no means necessary to suppose any extensive retrogressive metamorphosis of its vessels. . . .

"With regard to the *formation of the dentine* from the dentinal cells, it is certain that no other tissue than these cells contributes anything to its development; and that they, like those of the enamel membrane (clumns), become dentine by the gradual reception of calcareous salts."(1)

M. Lent, in a paper already referred to, describes a series of delicate processes, extending from the peripheral cells of the dentinal pulp. He regards them as the organs by which the dentinal tubes are formed, and, like the latter, they divide and anastomose together.

"Kölliker, who confirms Lent's observations, thinks it pro-

(1) Manual of Histology, by A. Kölliker. Translated by George Busk, F.R.S., and Thomas Huxley, F.R.S., Vol. ii.

bable that a single cell may generate a tube in its whole length; at the same time a cell is sometimes constricted, or incompletely divided into two, the more superficial of which becomes narrowed and lengthened into the dentinal tube. Kölliker is in doubt as to the origin of the intertubular substance, but is disposed to think that it is excreted by the cells in common, without structural relation to individual cells or their prolongations."(1)

Although it is not difficult to recognise many of the conditions attending the development of dentine as described by MM. Kölliker and Lent, there are others which my own observations have failed to verify.

In respect to the parenchyma of the dentinal pulp, M. Kölliker speaks of its relation to connective tissue. Now I have seen instances, and not uncommonly, in which connective tissue very similar to the stellate areolar tissue, could be traced in the substance of the pulp of a forming tooth, and in that of a tooth the development of which is completed, its existence is readily demonstrated. Again, the relations of the peripheral dentinal cells to each other, and to the cells placed internally to the outer layer, are not fully made out by the authors cited. If one cell, or even two or three only, is concerned in the formation of a dentinal tube throughout its whole length, it would be difficult to account for the presence of obliterated tracts of vessels found in the teeth of many animals, and occasionally in the teeth even of the human subject. I have several sections of molar teeth, in which large looped tubes, corresponding in size to the capillaries of the

(1) Elements of Anatomy, by Jones Quain, M.D. Sixth Edition. Edited by William Sharpey, M.D., F.R.S., and George Viner Ellis. Vol. iii.

dentinal pulp, are present in the dentine. Their position and size will justify the conclusions that they were once occupied by vessels—that they are the remnants of the vessels of the formative dentinal pulp. Now, supposing the parenchyma of the pulp had been bodily removed to make way for the centripetal or inward growth of the dentinal cells, it is not easy to see how these canals could have been left. But if the cells are produced in linear series, the more internal ones becoming gradually developed as the external undergo calcification, the persistence of obliterated vascular canals can be readily understood. It is true the existence of these canals in the dentine is quite exceptional in human teeth, but in the teeth of many mammals they form a constant character. The dentine of mammalian teeth, however, in other respects corresponds too closely to admit of the supposition that the process of development varies in any essential particular. If, for example, we take the developing incisor of a calf, and examine the pulp after withdrawing it from the investing cap of dentine, we shall find here and there long tubular processes projecting from the surface, the continuations of which may be traced into the substance of the pulp. Their size, position, and connexion with the pulp leave no doubt that they are obliterated capillaries, the coats of which have been retained while the cells around them have undergone calcification. Had the parenchyma of the pulp gradually made way for the inward growth of the external cells—the *membrana eboris* of Kölliker—these canals would surely have gone with it. I have made preparations in which several cells, more or less elongated in form, have been united end to end, not with that uniformity as regards size and position which characterizes the members of a

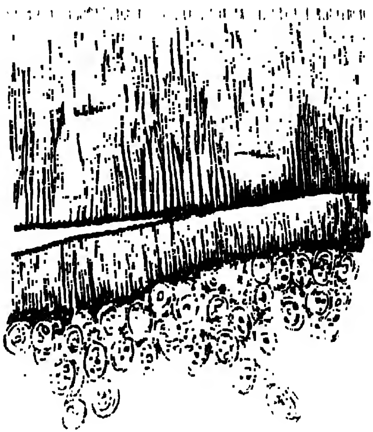
linear series of cells in ossifying temporary cartilage, but still their position and connexion with each other has been sufficiently distinct for positive recognition. Again, if we examine the peripheral cells in a pulp in which calcification is about to commence, and compare them with similar cells in a pulp taken from a tooth the development of which is approaching completion, it will be seen that in the former they are much smaller in size and more numerous than in the latter example.

It may be asked whether one element of the pulp more than another suffers absorption, in order to give space for the dentinal cells to grow, seeing that after the cap of dentine has been formed, it limits, by enclosing within its unyielding case, the general bulk of the pulp? Such a question can be answered only hypothetically. The pulp contains an infinite number of nuclei, any or a certain number of which are probably capable of becoming developed into cells. I believe it will ultimately be found that a growing cell, when placed in organized matter which is not itself in a state of development, is capable of growth at the expense of such matter, whatever may be the degree of its organization. It is quite clear that many of the nuclei, the vessels, and connective material, which constitute the dentinal pulp, disappear in favour of the dentinal cells prior to the calcification of the latter; and the manner of their disappearance, although not fully made out, will, I feel but little doubt, prove to correspond with that process by which the tissues of a temporary tooth disappear before the growing papilla, as described in a previous page.

M. Lent has described the long slender processes which extend from the free surfaces of the dentinal cells; and he, with M. Kölliker, regards these processes as the

organs by which the dentinal tubes are produced. It does not appear to be thought that the cells themselves form the tubes, or that they contribute by simple calcification any portion of the intertubular tissue. The following figure was taken from a tooth, the development of which was not complete.

Fig. 126. (1)

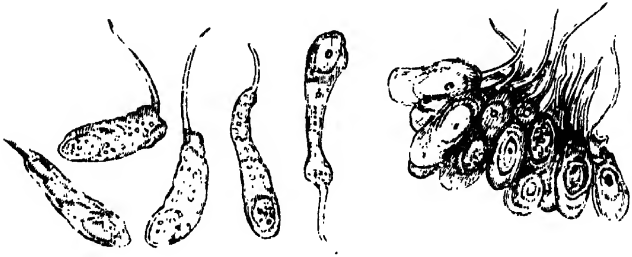


The preparation was made by breaking the tooth through the centre immediately after its removal from the mouth, and cutting with a sharp scalpel a very thin fragment from the edge of the pulp-cavity, the pulp itself being present at the time. We have in this example the dentinal cells adherent to the developing dentine, and the continuity of the calcified and uncalcified tissues clearly shown: and further, that it is only necessary for the cells to become hardened,

(1) Showing the appearance presented by a section cut with a sharp knife from the edge of the pulp-cavity of a tooth recently extracted. The peripheral dentinal cells are retained in their natural position as respects the developing dentine.

and as it were fused together, by the reception of the salts of lime, in order to convert them into a mass similar to

Fig. 127. [1]



the dentine to which they are attached. There are, however, certain appearances presented by dentine slowly softened by caries, to which, as affording evidence bearing upon the subject of development, allusion should at this point of the inquiry be made. If we take a carious tooth in which the progress of the disease has been slow, and the diseased part consequently firm, and of a deep brown colour, and make thin sections with a knife transverse to the direction of the dentinal tubes, it will be found by the use of the microscope that the preparation is made up of comparatively large discs, each having a central aperture or mark, and that the discs are united to each other by an interposed tissue, small in amount, but capable of distinct recognition. Now, these discs have a much greater diameter than the dentinal tubes, as seen in a transverse section of healthy dentine, but they correspond in diameter with the dentinal

(1) Dentinal cells, which became detached, and floated about in the fluid in which the preparation forming the subject of the foregoing illustration was placed for examination.

cells, as shown in the preceding illustration. If it be allowed that the cells undergo calcification, the conditions presented by the carious dentine can be accounted for on assuming that, by the slow rate of decomposition which marks the progress of caries, the formative elements of dentine become manifest; or in other words, that the formative cells, the outlines of which had been perfectly obliterated by calcification, are, during the progress of disease, again rendered apparent.

In the diseased tissue the tubes appear to have extremely thick walls, so that but little space is left for an intertubular connecting tissue, whereas in healthy dentine the diameter of the tubes is relatively small, and the amount of intertubular tissue is comparatively large. The different characters seen in the two cases may perhaps admit of explanation on the following hypothesis, namely, that the appearance of defined parietes to the tubes in healthy tissue, is due to a higher or lower degree of calcification in the tissue which forms their parietes than in that of the intervening parts, and that this difference is lost under certain conditions of disease, while the outline of the original formative cells is rendered apparent by the removal of the earthy ingredient which, in the process of calcification, had effaced the difference which distinguished the dentinal cells from the medium by which they were connected together. It is quite possible to conceive that an equal degree of calcification would efface the differences which were apparent in the soft tissue prior to its induration, and that a higher or lower degree of calcification in the part in immediate contact with dentinal fibrils, would produce such a distinction of parts

as that which characterizes the dentinal tubes; and that decalcification might, under favourable circumstances, restore an appearance which had been lost, and obliterate one which had been produced by calcification.

The views which have been recently put forth on the subject of calcification, together with the conditions which under certain circumstances attend the formation of dentine, will throw some light upon, or furnish some evidence in favour of, the correctness of the preceding hypothesis. Mr. Rainie finds that if carbonate of lime is formed in a thick solution of mucilage or albumen by the decomposition of carbonate of soda or of potash, that the newly formed salt takes a globular instead of a crystalline form. The globules produced are composed, however, not only of carbonate of lime, but also of a certain portion of the mucilage or albumen in which the combination has taken place. In proof of this assertion, he states that the lime may be removed by an acid, without occasioning the destruction of the form of the globule from which it has been so abstracted; just as the form of a bone is maintained after the earthy matter has been removed. It is further stated, that phosphate of lime, if produced under similar circumstances, supposing a minute quantity of carbonate of lime be present, will, like the carbonate, assume the globular form. These globules are laminated in structure, and appear to be capable of increase by the addition of new layers upon the surface. If two or more lie in contact, they become perfectly united into one laminated mass, by the blending or fusion of the laminæ which come in contact. The globules themselves are stated to be produced by the coalescence of

smaller masses, which again are made up of still smaller spherules of similar material; the individuality of the constituent bodies being ultimately lost in the uniform fusion of the whole into one compact mass. Globular masses which at one time have a rough and mulberry-like appearance, gradually, by the coalescence, and as it were fusing down, of the constituent spherules, become perfectly smooth. The lamination is supposed to result from the arrangement of the masses in concentric layers, and their subsequent coalescence. In the discovery of the substitution of the globular for the crystalline form of these two salts of lime, Mr. Rainie considers he has found an explanation of the process of calcification, not only of bone and teeth, but also of the formation of shells. Now there are certain appearances in some specimens of recently-developed dentine which favour Mr. Rainie's views.(1) I have specimens which, when carefully examined, exhibit faint outlines, as if formed by spherical masses perfectly embedded in the surrounding dentine, the outline of the globular part being distinguished from the interglobular portion by a slight difference of density only. The dentinal tubes pass ordinarily through both parts without suffering any changes of form or size, and consequently tend to obscure rather than render apparent the want of perfect uniformity of structure in the intertubular matter. Dentine in the globular form may be found in semi-detached masses adherent to the surface of the pulp-cavity, and in perfectly detached spherules in the substance of the pulp itself, in the teeth of adults. In the

(1) A full account of Mr. Rainie's views will be found in the British and Foreign Medico-Chirurgical Review, No. xl., Oct. 1857.

latter situation these bodies are very abundant in teeth which have been attacked by a caries; and Mr. Salter appears to consider the presence of the detached masses of dentine in the pulp as the consequence of disease. I do not think this view is quite correct, for in three out of five specimens of perfectly sound molar teeth removed from subjects in the *post-mortem* room of the hospital, I found globular masses of dentine within the substance of the pulp. Again, in the developing teeth of ruminants, these globular masses are scattered freely through the dentinal pulp, and as ossification advances, become surrounded by, and lost in, the general mass of the dentine. If the surface of the pulp-cavity of a partly formed tooth of a ruminant be examined, the globules will be found embedded to various depths in the substance of the dentine. Mr. Rainie's researches appear to offer a more satisfactory explanation of the manner in which these globules arise, and ultimately become blended in the dentine, than is afforded by any other hypothesis which has hitherto been advanced. There is, however, still much to be learned upon the subject of the development of the osseous tissues before our knowledge can be regarded as satisfactory.

The recognition of calcification in the form of detached granules, which afterwards coalesce into globular masses, and these again becoming ultimately blended into the substance of the tooth, will serve to explain how dentine is produced in teeth structurally imperfect, rather than to afford a solution of the manner in which calcification takes place in faultless teeth, during whose development neither large nor small globules or spherules could be detected; on the contrary, the dentine in its inward progress advances in a clear unbroken line, perfectly

free from such interruptions as the presence of attached globules of dentine would produce.

Although the presence of defects in the structure of the dentine no doubt contributes to hasten the destruction of teeth when attacked by caries, yet, as a predisposing cause, they are secondary in importance to similar faults in the organization of the enamel. Sufficient importance, however, attaches to the departures from the normal condition of the dentine, to render it desirable that some account should be given of the characters by which such departures are distinguished.

When the organization is perfect, the subdivisions of the dentinal tubes pass up to the line of junction formed between the inner surface of the enamel and the outer surface of the dentine, the intertubular tissue being at this point clear and transparent. In less perfect teeth the clearness and transparency are replaced by a granular condition of the tissue; granules, or spherules, or minute globules, although united, yet retain some traces of their individuality, and among these the coronal dentinal tubes are lost. This condition, in a greater or less degree, is almost uniformly present in the peripheral portion of the dentine of the root; but its existence in the crown of the tooth must be regarded as an indication of faulty development. In seeking to explain the cause of this granular condition, Mr. Rainie (if I have read his paper correctly) would regard the phenomenon as resulting from an arrest in the coalescence of the dentinal globules. Others would regard the appearance as due to the calcification of the peripheral cells of the dentinal pulp prior to the completion of those changes which necessarily precede the development of dentinal tubes.

A second form of imperfection in dentine is one which has been characterized by some authors as globular, and by myself as areolar dentine. Czarmac published a paper upon the subject. He looked upon the peculiarity of the structure to be due to the presence of globules of dentine, which, when placed close together, necessarily left irregular intervals. These intervals, whether subsequently filled up or not, were secondary, and consequent upon the globules. I, on the other hand, regarded the intervals as the primary, and as the more solid part, while the spherical masses were considered as secondary and dependent. This view of the structure I am not prepared to fully maintain, or altogether to abandon. M. Czarmac no doubt described correctly the specimens at his disposal, but there is reason for believing that there are two conditions which on first sight appear to be similar, and that he did not recognise the distinction. In the one, the globules are very distinctly marked by the imperfect tissue which fills up the interglobular spaces, or by the absence of tissue in those intervals. In the other condition, the part corresponding to the interglobular spaces is occupied by dense tissue, which gives uninterrupted passage to the dentinal tubes, but at the same time presents an appearance of great solidity, and is bounded by a very definite outline. This state I have compared to calcified areolar tissue—areolar tissue such as may sometimes be found in the dentinal pulp.

According to Czarmac, the globules are the primary, and the interglobular matter (when such matter exists) the secondary, production. According to the views advanced by myself, the areolar or interglobular is the primary and independent production, consequent not upon the mere filling in

of intervals, but upon the calcification of a tissue existing as an exceptional condition of the dentinal pulp. At the time these opinions were published, many preparations were before me, in which the areolar arrangement of the dentinal tissue was so strongly marked, and the idea that the structure was due to the calcification of areolar tissue was consequently so firmly impressed upon the mind, that those cases in which globules of dentine were separated by imperfectly filled intervals came to be regarded as the consequence of imperfect calcification of the areolar tissue.

Whether the two conditions of dentine are produced by the same or by different causes may be questioned, but there can be no doubt as to the different consequences which result from the presence of the one or of the other defect. Teeth in which the globules and interglobular spaces are present very rapidly suffer destruction when attacked by caries —a result which is consequent upon the porous state of the tissue; on the other hand, the presence of the areolar state is attended by a difference in the physical condition of the dentine, the density of which is rather above than below the normal amount; consequently the progress of caries in teeth so constituted is comparatively slow. We often see "honey-combed" teeth in which this state of tissue prevails, and although nearly destitute of enamel, yet hold their place and fulfil their office for many years. But had interglobular spaces been substituted for the areolar arrangement of dense tissue, the teeth would have rapidly been reduced to the level of the gum.

In respect to the dentinal tubes themselves, there are certain exceptional conditions which may be noticed, as to some extent compromising the durability of the teeth in which they occur. Any change in the direction of greater

porosity of the dental tissues, may be regarded as favourable to the destruction of teeth, supposing them to be attacked by caries; and it is only to such forms of departure from the normal state of the tissue that attention need be directed. Under ordinary circumstances, the dentinal tubes diminish slightly in diameter as they approach the peripheral portion of the crown of the tooth, but it will in some specimens be seen that in passing an interglobular space they are considerably dilated. Again, the terminal coronal branches instead of terminating by anastomosis or by becoming imperceptibly minute, may pass into small irregular cavities situated near the surface of the dentine.

In a well-developed tooth a certain number of the dentinal tubes will be seen to pass across the line which marks the junction of the enamel and the dentine, without suffering any increase in size, and after proceeding a short distance in the former tissue, become extremely minute and are lost. But in teeth of less perfect organization the dentinal tubes, after passing into the enamel, become suddenly dilated into comparatively large elongated cavities, somewhat irregular in outline, but tolerably uniform in their direction. Without following closely the course of the enamel fibres, they have a general direction towards the surface of the tooth, and terminate abruptly after advancing but a short distance into the substance of that tissue.

Many other deviations from that which must be regarded as the normal form of the dentinal tubes, have been already described,* and might now be enumerated, but that they for the most part are strictly local, being often confined to

(1) Lectures on Dental Physiology and Surgery.

a few tubes, and are consequently incapable of exerting any influence upon the teeth in which they occur, hence the enumeration does not fall within the scope of the present work.

The structure of the cementum will be described before treating upon its diseases.

The structure of the enamel and the dentine has been entered into at some length, prior to treating upon the diseases to which they are subject, on the supposition that the organization of a part should be kept clearly in view when an attempt is made to appreciate the nature of its diseases.

Caries.—The enamel and the dentine are the tissues which are more especially liable to be affected by caries. In them the process of destruction commences. The disease may extend to, or may even commence in, the cementum in teeth from the necks of which the protecting gum has been removed. But these are exceptional cases, we may therefore, for the present, treat of the disease as an affection of the enamel and dentine only, leaving for future consideration the results which follow when the disease becomes complicated by extending so far into the tooth as to lay open the pulp-cavity, and involve the pulp itself in rapid destruction or in chronic disease.

Although dental caries has been investigated and described by all who have written upon the subject of dental surgery from the earliest period when disorders of the teeth first attracted attention down to the present time, yet it can scarcely be said that the nature of the disease is perfectly understood; for even now two hypotheses prevail. In one, the disease is assumed to be no disease whatever, but merely the result

of chemical decomposition, and dependent wholly upon the operation of chemical laws both for its origin and progress. In the other hypothesis, it is assumed to be the result of morbid action upon a vital organism. Mr. Robertson holds and fully expresses the one, and Mr. Bell as clearly states the other class of opinions. But in the works of neither do the authors give a description of the structure of the affected tissues. Mr. Bell's treatise was written before the histological characters were fully made out, indeed, before the achromatic microscope had been rendered generally available for anatomical purposes;(1) and Mr. Robertson does not consider that the recent investigations have thrown any light upon the subject of dental caries.

A satisfactory account of the manner in which dentine is developed has but recently been given, and the recognition of the presence of fibrils of soft tissue in the tubes dates back but a few months. Hence it is not wonderful that the diseased conditions of a tissue the structure of which was not understood, should have remained in obscurity. With our increased knowledge, the subject will, however, admit of more satisfactory treatment.

The physical signs which mark the presence of caries, are first visible in or through the enamel. But they will vary somewhat in accordance with the character of the surface affected. If the disease arises in a fissure in the masticating surface, or in a depression in the crown of the tooth, a dark-coloured spot will be the first indication of its presence; but if the disease has attacked a surface free from any indentation or fissure, the affected part will lose its translucency, and become opaque

(1) Transactions of Odontological Society. Vol. i.

and white; subsequently the white will be succeeded by an ash or slate, and finally by a brown colour, more or less deep. If the enamel be examined when in the earlier stages of disease, it will be found that the presence of opacity is accompanied, and no doubt occasioned, by an increased porosity of the tissue, a condition which has succeeded to one of the forms of imperfect development already described. Either the union between the sheaths of the formative fibres has been imperfect, and the strictly fibrous condition has been maintained until, under the influence of disease, the union, at best but imperfect, becomes sufficiently interrupted to give opacity to the parts; or the granular condition previously alluded to has been continued, and thus rendered the tissue susceptible to influences which would have failed to produce any injurious effects had the organization been more perfect. The predisposing causes to disease have, however, been described in connexion with the structure and the development of the enamel, and the description need not be repeated. After recognising a distinction between the central and the external portions of the so-called fibres, and the more rapid action of a mineral acid upon the contained than upon the containing part, it may reasonably be expected that some such difference would be observed in enamel when undergoing changes from the action of disease. It would be most difficult to obtain a transverse section of enamel which has been subject to the changes produced by caries, but we may, by breaking down upon a glass slide fragments of the brittle and chalk-like enamel taken from a carious tooth, produce a sufficiently satisfactory preparation for demonstrating the fact that the central

portion of the fibre is the first to suffer decomposition, much in the same manner as when the destructive agent is intentionally applied to a section prepared for experimental treatment.

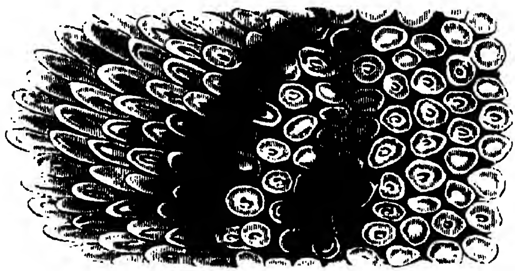
The foregoing description applies to those cases where the disease has commenced upon a surface free from depressions, and extended through the porous enamel into the dentine. Not that the process of decay materially differs in conformity with the character of the surface attacked, but the progress is somewhat varied, both in respect to the direction in which the disease extends, and in the rate of destruction. When the disease is established in a fissure, the indications of its presence are not strongly pronounced until a very considerable amount of destruction has been produced. A consequence which results from the disease having extended into the dentine, penetrating to a considerable depth in the direction of the tubes, and spreading laterally under the enamel, without affecting its outer surface: with the softening of the dentine, the inner surface of the enamel becomes softened from within, until the tooth at that point is so much reduced in strength that the enamel breaks in, and suddenly reveals a large and scarcely suspected cavity.

For the convenience of description, the disease, when it assumes this form, may be termed penetrating caries, reserving the terms, spreading caries, for the form previously described.

As respects the dentine, the progress of decay does not follow the same course as that which has been described in reference to the enamel. It will be remembered that the dentine is formed from cylindrical cells, or rods, of the dentinal pulp, the individuality of which is lost in the

process of calcification. If we take a thin section from a carious tooth, it may be seen, in those parts of the preparation where the tubes are divided transversely, that each tube is surrounded by a very thick sheath—the diseased condition has, in fact, restored the outline of the formative-cells,—the tissue is to a certain extent broken up into its histological elements. Under the microscope the section looks as though it might have been built up of multitudes of tobacco-pipe stems, united by an intervening substance. Such is the con-

Fig. 128. (1)



dition when disorganization has advanced up to a certain point; at a later period the distinction of parts is lost, and the whole tissue breaks down into minute granular particles, which are by degrees washed away in the saliva.

The first chemical change consists in the removal of the phosphate of lime from the gelatine, leaving the dentine of a consistence capable of being readily cut with a sharp knife, and exhibiting the structural characters just described. It might be supposed that similar results would be produced from decalcifying a tooth by the aid of a dilute mineral acid;

(1) A section from dentine softened by caries, showing the consolidated dentinal tubes and fibrils cut transversely.

such, however, has not been the case in experiments instituted with the view of determining the point. Indeed, I know of no artificial means whereby the appearances which have been described can be as fully brought out as by the progress of disease. The question naturally suggests itself, may not the appearance of dentinal rods be nothing more than a certain stage in progressive decomposition, due to a solvent fluid obtaining access to the tissue through the tubes, and the outline of each rod be indicative only of the depth to which the fluid has permeated? If this were true, the parietes of the tubes would be the first to break down, whereas they are not uncommonly the last to disappear. The connecting material is usually the first, and the walls of the tubes the last, to become disintegrated. Occasional exceptions to this sequence of disorganization, will, however, be found in teeth which are destroyed with great rapidity. In them the tubes will appear to have become enlarged in the manner figured in my previous work; and the distinction of the tubular and intertubular parts of the tissues will be but faintly pronounced, and indeed may be altogether wanting. But supposing a section from a carious tooth, in which the destruction has been gradual, be taken, the following conditions may be observed; commencing at the part where the dentine presents pretty nearly its natural appearance, we then pass to a point where the outline of the formative elements has reappeared; still further on, this condition becomes yet more strongly marked; and at the extreme edge, supposing the section to have extended to the surface of the cavity, the process of disintegration may be seen.

If a tooth in which the disease is limited in extent, be divided, the relations of the diseased to the healthy parts

may be examined. The affected dentine will be either opaque in appearance, or it will have assumed a brown colour; and these changes from the condition of health will be seen to extend underneath the enamel beyond the limits which bound the external indications of disease in that tissue. But it will be in the direction of the dentinal tubes that the disease will be found to have made the greatest progress. Supposing the disease to have commenced upon the masticating surface of a molar tooth, it will commonly be found that the mass of diseased tissue, when limited in amount, presents the shape of a cone, the apex of which is directed towards the pulp-cavity, and the base towards the enamel.

The section will show that the destructive agent, having gained access to the dentine through an opening in the enamel, has spread, to a certain extent, upon the peripheral surface of the tissue, through the terminal branches of the tubes, and thus formed the base of the cone; but that it has spread to a greater length in the course of the trunks of the involved tubes following their convergent course towards the pulp-cavity, and thus produced the apex of the cone. But if an example be taken in which the disease has assumed the spreading character, the conical form of the disorganized part will be less strongly, if at all, pronounced. In certain cases, indeed, the whole of the masticating surface of a molar tooth is lost before the disease has advanced to a sufficient depth in the direction of the pulp-cavity to expose its vascular contents. In the defective teeth described as "honeycombed teeth," the disease, after the enamel has been destroyed and the dentine reduced in thickness, becomes in certain cases arrested. The exposed tissue assumes a polished surface, deep brown colour, and acquires a density which enables the crown,

though deprived of enamel, to serve the purpose of mastication with scarcely less efficiency than an uninjured tooth.

Vital Phenomena.—We have hitherto spoken of the physical character of caries, but there are vital phenomena which are coincident with structural changes in the dentine, and mark the presence of the disease; and of these we have yet to speak.

I believe it rarely happens that the presence of caries in its earlier stages is altogether unattended by some uneasiness in the affected tooth. The amount is often very slight, so slight that the attention will be directed to the part in those only who are in the habit of devoting considerable care to the preservation of the teeth: on the other hand, there are many who immediately recognise the presence of disease by the discomfort it occasions; and in exceptional cases the patients describe the affected teeth as giving them a considerable amount of pain long before the disease has progressed to an extent capable of directly involving the pulp. Toothache of this description must be distinguished from that which is consequent upon inflammation of the pulp, whether resulting from exposure produced by caries, or arising from any other cause; and the distinctions may be made by observing the characters of the pain. There is an absence of throbbing, and a less degree of intensity as compared with that occasioned by inflammation of the pulp. Contact with hot or cold fluids does not usually produce any unpleasant effect.

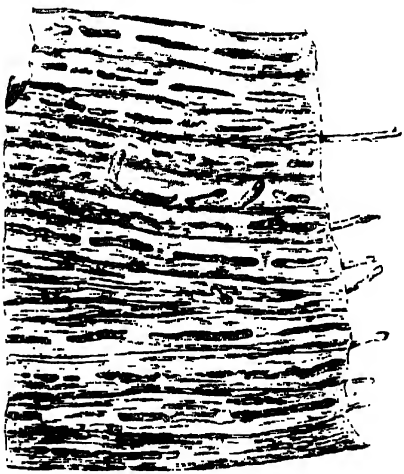
I believe the seat of pain to be mainly in the peripheral portion of the dentine, and that after the destruction of vitality in this part of the tooth has been completed, the sensation of discomfort in great part passes away.

No doubt there are cases in which the presence of caries is unattended with any feeling even of discomfort, for we find those in whom the pulp becomes exposed and disappears without a moment's toothache. If a part endowed with vessels and nerves, and a very high degree of sensibility, can be destroyed without pain, as it were unconsciously, it would be unreasonable to suppose that the dentine cannot undergo disintegration without manifesting sensation. Why in one person the destruction of a tooth should be attended with so much, and in another with so little suffering, is a question which we are as little able to answer, as we are to account for the great difference in susceptibility to the action of remedies, so frequently manifested in patients in whom such constitutional peculiarities can be discovered by experiment only.

The presence of increased sensibility is not, however, the only vital action which the dentine exhibits when attacked by caries. The dentinal fibrils are subject to organic change more or less complete, the existence of which may be recognised even by the naked eye. If we divide a sound tooth through its long axis, the dentine exposed by the section will present a tolerably uniform degree of opacity; but if the tooth has been attacked by caries, in addition to the discoloration of the part which has undergone chemical change, we shall find a comparatively transparent zone removed a short distance from, and surrounding the disorganizing mass. If a thin section be taken from the tooth, it may then be seen that the transparency is produced by the consolidation of the dentinal fibrils within the tubes, thereby obliterating the latter, and rendering their outline obscure. The consolidated condition of the fibrils may, however, be shown in a more satisfactory manner by taking a

tooth in which the progress of decay has been slow, leaving the disorganizing dentine of a deep brown colour, and comparatively firm in texture. If we cut with a sharp knife a thin section in the direction taken by the dentinal tubes from the discoloured portion (if the tooth be well selected), the calcified fibrils will be seen within the tubes broken abruptly into short lengths. Sometimes they are present in great numbers, scattered over the specimens, many lying within the tubes, others upon the surface, and occasionally

Fig. 129. (1)



they may be seen with one end projecting from the edge of the section, and the other within the tube.

(1) A section in a plane with the tubes, from carious dentine, showing consolidation of the fibrils, some of which are seen projecting from the edge of the specimen, while others have been broken within the tubes and are displaced.

This calcification of the fibrils necessarily exercises a considerable influence in arresting the progress of disease, by rendering the dentine much more dense and impervious than when in the normal state. The zone of consolidation cuts off and isolates the diseased from the healthy portion of the tooth, and its production must be regarded as an attempt on the part of nature to circumscribe and limit the mischief. That this interpretation of the phenomenon is correct, will be seen on examining teeth in which the rate of progressive destruction has varied, and also by considering the conditions presented in other tissues when they are attacked by local disease.

In respect to teeth, it will be found that when the dentine has been rapidly destroyed—when, in fact, the amount of softening is great, and the external indication but comparatively slight—when that which at first sight would appear to an unaccustomed eye a small cavity, is, on the removal of the disorganized tissue, found to be a very large one; that the consolidation of the fibrils has been imperfect, or perhaps altogether wanting, and that there is coincidently a high degree of sensitiveness under operation. Again, compare the foregoing case with one in which the destruction has been comparatively slow, and the extent of the disease more limited, and it will then be seen that the evidences of consolidation are in the former very slight, and in the latter very abundant. It will, in fact, be found that the rate at which the disease advances will accord with the amount of consolidation; in other words, the restrictive efforts of nature will to a great extent determine the rate of decay. It must be borne in mind that the disease is, for the present, regarded as strictly limited to the dentine and enamel, and that the teeth are

assumed to be in an otherwise healthy condition. When the pulp becomes exposed, or when the gums have receded and exposed the necks of the teeth, other conditions come into operation, and modify the symptoms.

Having entered at some length into the organization of the dental tissues when in a state of health, and into the conditions manifested when they become diseased, we are now in a position to consider the much discussed question of whether vital action has or has not any influence either in the production or in the arrest of caries.

Those who regard exclusively the physical characters presented by the carious mass in a decayed tooth, come to the conclusion that chemical action is alone concerned in its production, and that it is unnecessary to refer to vital action in order to fully account for all the conditions which are observed. Supposing this view to be correct, we should be justified, after examining a portion of sloughing skin, in coming to a similar conclusion as to the manner of its production. In each case the mere decomposition of the part is the result of chemical action. But the conditions which have preceded the formation of a slough, and the state of the surrounding tissues after it is formed, cannot be disregarded. In the case of the skin, the part which encircles the slough becomes indurated by the infiltration of lymph; in that of the dentine, by a changed condition of the fibrils. In the one case the dead becomes separated from the living part by a natural process, in the other that separation does not occur. The occurrence of a separation in the one and not in the other instance, does not, however, prove that the one tissue is possessed of vitality, and that the other is destitute of life. But in respect to the

soft tissues, the precise manner in which dead is detached from the living part is not fully ascertained. The presence of increased vascularity is, however, uniformly recognised, at and near the boundary of the living tissues, the outer surface of which by degrees assumes the character of a secreting surface pouring out pus into the disorganizing part. The slough, even after it is infiltrated with pus, is firmly attached to the living part from which it is eventually separated, but only by slow degrees. It is usual to ascribe the ultimate separation to disintegration resulting partly from mere decomposition of the part itself, and partly to a solvent power exercised upon it by the secretions. Perhaps this explanation of the manner in which nature throws off the dead from the living part, may be thought sufficiently satisfactory if applied to the soft tissues only; but in the case of the death and ultimate separation of a portion of bone, the assumption that the process of detachment partakes of the nature of ordinary decomposition of the dead part, fails altogether to account for the attendant phenomena.

In a previous page the process of absorption, as it occurs in teeth and bone, has been described at some length, and to this the reader may be referred for an explanation of the manner by which a portion of dead bone is thrown off the living structure. A layer of the osseous tissue is absorbed, the removal of which disconnects the living from the dead bone. In necrosis the manner of separation is more distinctly seen than in caries, as in the former the dead portion usually separates in a single mass, while in the latter the bone comes away in numerous small fragments, but in each case I believe the means by which the separation is effected will be found to

be the same. Now in dental caries there is no attempt to detach the diseased part, and if the subject be carefully considered, it will be seen that the organization of the dentine does not afford the means for effecting such a separation. In the cases cited, capillaries for the circulation of red blood were present; but in the dentine we have no such vessels distributed through the substance of the tissue. We see that a portion of tooth is not uncommonly absorbed, but the process is commenced either upon the surface of the implanted part of the tooth or that of the pulp-cavity, and the agent arises from the periosteum or the dentinal pulp, as the case may be. But it is not found that absorption, although often consequent upon dental disease, arises in immediate connexion with caries. Still, the absence of that power by which a dead is thrown off from a living part, would by no means prove that the dentine is destitute of vitality, even were the positive evidence afforded by its sensitiveness and its organization less conclusive.

There cannot be any difference of opinion as to the mere chemical character of the processes by which the enamel and the dentine are softened by the removal of the earthy matter, and ultimately disintegrated; but this process must be regarded as a consequence secondary to some preceding change in the part rather than as a primary condition.

Those predisposing causes resulting from imperfect development of the tissues have been pointed out, but the exciting causes of caries have yet to be considered. The occurrence of inflammation in the dentine has been regarded by many authors as an exciting cause, but if the presence of pain, heat, and redness in the part (the usual signs of inflammation) be

required in support of this opinion, we should fail in the demonstration. It is not, however, necessary that the presence of inflammation should be proved in order to establish the fact that the dentine has undergone organic change, corresponding in the essential characters to those which take place in other tissues, independently of the secondary effects upon the vessels which supply them with nutrition. The dentine under ordinary circumstances is sensitive, and the sensitiveness may be greatly increased by disease, so that the slightest pressure upon the part produces pain; on the other hand, the sensibility, as before stated, may be altogether lost. The dentine being a non-vascular tissue (in the ordinary acceptation of the term), is incapable of becoming red from increased vascularity. The cornea may become injected with red blood, because in its normal condition colourless liquor sanguinis circulates through minute vessels, and these vessels, under the influence of disease, may become dilated sufficiently to admit the red globules of the blood; but in dentine the vessels for the circulation of the liquor sanguinis are wanting, and even were they present, their dilatation within the substance of the dentine would be limited. The dentine may be stained by decomposed blood, but it could not be rendered red otherwise than by the dentinal tubes undergoing considerable dilatation, and subsequently becoming tenanted by vessels sufficiently large to admit blood-globules. The fulfilment of these conditions would involve the production of new vessels in canals specially prepared for their reception, and the manner of preparation would be peculiar. In bone, the Haversian spaces are the first to appear, and it is by the contraction of these

spaces by the formation of concentric laminæ of bone, that the Haversian canals are formed. If dentine were to become vascular under inflammation, the process would probably correspond to that which is seen to occur when new vessels are formed in bone. But we have no evidence in favour of the supposition that the change in circulation which indicates the presence of inflammation in soft tissues, occurs in dentine. It is not, however, necessary on this account to assume that the dentine is incapable of alterations from morbid action, otherwise than such as are occasioned by decomposition of the affected part. The capillaries are, after all, secondary in importance, and subservient to the special tissues in the intervals of which they are distributed, and for the nutrition of which they are created. The distance of these intervals, or in other words the degree of vascularity, varies in the different tissues. In dentine they are very large as compared with any other structure, the pulp-cavity being under ordinary circumstances the only part at which they are present, external to which in the crown of a tooth we do not find a vascular canal. Apart from the well-known alterations which the vessels undergo in inflammation, the tissues themselves are subject to structural changes of the highest degree of importance, and it is to such changes that we must look when the morbid conditions of dentine are compared with the diseases of other tissues. It appears, however, that attention has for the most part been directed to the vascular system, while the tissues to the purposes of which the vessels are subservient have been examined with less success.

Possibly the primary effects upon the tissues may not, with the means at our disposal, be capable of detection, but

supposing this to be the case, we cannot doubt their presence, or fail to recognise their importance. For illustration, we may take the experiment with which most people are familiar —viz., that of applying an irritant to the web of a frog's foot when under the field of a microscope. If the skin be scratched with the point of a needle at some little distance from a vessel, so as in no way to injure the coats of the latter, the first effect which strikes the eye is an increased velocity in the current of blood and a contraction of the vessel. Subsequently the vessel becomes dilated, and the blood gradually loses its velocity, flows irregularly, and at last becomes stagnant. In the meantime the tissues surrounding the vessel become infiltrated with lymph which has escaped through its coats. All these changes are strictly secondary, and consequent upon an alteration produced by wounding one or more of the special tissues external to the vessels, but we do not recognise the nature of that alteration.

In speaking of the predisposing and exciting causes of caries, allusion has yet to be made to those agents which may be regarded as capable of acting in the double capacity of depriving the dentine of its normal powers of resistance, and of producing its immediate decomposition.

In considering the subject from this point of view, we must be prepared to admit that the dentine is possessed of vitality, and that that vitality must have been lost before the tissues undergo decomposition. If we take, for example, the effect produced on the skin by the application of caustic potash, the immediate result is the destruction of vitality in the part with which it comes in contact; and its secondary effect will be

the disorganization of the part destroyed. But had the power exerted by the potash been incapable of depriving the skin of vitality, the secondary effect—that of producing decomposition—would have been successfully resisted. In the case of a tooth, the application of potash would not produce conclusive results; but the use of a mineral acid would be followed by consequences similar to those mentioned with respect to the skin. The vitality of the part would be destroyed, and decomposition would succeed the loss of life.

It may be said that agents of this active character are not applied to the teeth, but such as have sufficient power to destroy are applied, and it is by taking an extreme case that we are best able to examine the mode of action and the ensuing results.

Litmus paper applied within the cavity of a carious tooth almost invariably gives strongly-marked acid reaction, and thus furnishes evidence of the existence of an agent capable, if unresisted by the vitality of the dentine, of depriving that tissue of its earthy constituents, leaving the gelatine to undergo gradual decomposition, favoured by the heat and moisture of the mouth.

In examining the circumstances under which the decomposition of the dentine takes place, and under which it is resisted, apart from the influence of vitality, any one must be struck with the power that is exerted by the mere form of the surface involved. Supposing the disease to be situated in a deep fissure, or upon the side of a tooth, against which another tooth is placed, the decomposition will go on with more or less rapidity, the rate being varied in accordance with the condition of the oral fluids. But if the cavity be

superficial, and so placed that it is subject to friction during mastication, the progress is usually relatively slow; and if the low walls of such a cavity be removed, the part will become polished by the act of mastication and by the motions of the tongue, and decomposition will be completely arrested quite independently of any power of resistance exercised by vital action. Again, let a tooth be placed under circumstances the opposite of the preceding. For example: take a bicuspid of the upper jaw, the distal surface of which is decayed, and remove the softened dentine; then let dry cotton wool be forced between the defective tooth and its neighbour, and renewed only once in three or four days; at the end of a fortnight or three weeks it will be found that the surface of the cavity which was left hard and dense after the first operation, has become soft, and that the softening extends to a considerable depth. Had the cotton, prior to its introduction between the teeth, been dipped into a solution of any resinous gum, such as mastic, the surface of the cavity would have remained unaltered, owing to the exclusion of moisture. But where wool only is used, the secretions of the mouth are not only not excluded, but are held in constant apposition with the exposed dentine by the saturated wool.

Experiments of this character lead to the conclusion that within the mouth agents are present which, under favouring circumstances, are capable of decomposing the dental tissues, and the source of these agents becomes the next question which naturally suggests itself.

The secretion from the mucous membrane is ordinarily slightly acid, while the salivary fluid, when normal, is alkaline.

The result of the admixture of these, if equally proportioned, would be a neutral fluid. In certain conditions of health even the saliva may be acid, and the mucus would then retain its original character after the mixture of the two fluids. Again, the degree of acidity of the mucus may be increased beyond the normal amount, and its tenacity may enable it to remain in certain situations unmixed, and consequently uninfluenced by the alkaline character of the salivary fluid. The quantity of the mucus may be excessive either from a local or a general cause. We not uncommonly find in mouths tenanted by numerous carious teeth, the gums thickened and vascular, and covered with a coating of thick adhesive mucus capable of being drawn from the gum in long strings. A case is fresh in my memory in which the teeth were rapidly destroyed by caries, and coincident with the destructive process the salivary fluid was scanty in amount. The mouth owed its moisture to the secretion of the mucous membrane. The patient complained of great discomfort from the dry and clammy condition of the mouth and throat. The teeth that were first lost decayed in those situations in which we usually expect caries to show itself; but at a later period the whole of the remaining teeth were almost simultaneously attacked near the edge of the gum, producing round each tooth an annular belt of softened tissue. The patient suffered from long-standing dyspeptic symptoms; and among these, a vitiated condition of mucus secreted from the surface of the mouth, and a diminished amount of saliva, formed prominent features.

In the foregoing case there could be no doubt that the state of the oral fluids was dependent upon the general condition of the body; but in many cases it is by no

means easy to determine how far the disorder of the teeth is dependent upon a general derangement of the system having a coincident existence, or how far the general disturbance of health may be dependent upon the diseased condition of the teeth. Young people are often brought to us in whom, coincident with the extensive development of caries, we find an abundant flow of saliva, and a free secretion of mucus; but I think the latter is usually in excess, and is found clinging to the teeth, instead of becoming dissolved in the saliva. In cases like those just cited, I believe we must regard the mucus as furnishing the agent by which the dental tissues are decomposed, and this opinion has been strengthened by the results which followed upon treating several teeth in a manner calculated to test the capability of the mucous membrane to furnish an agent destructive to the teeth. The softened tissue was removed from a cavity on the distal side of a first bicuspid of the upper jaw, and some dry cotton was forced between the bicuspids in such a manner as to press strongly upon the gum. The cotton was renewed once in three days. After the first application the gum became slightly inflamed, and bled on the removal of the cotton, and in the course of a fortnight the softening of the dentine was found to have extended to a considerable depth, showing forcibly that the rate of decay had been increased by the treatment. Having frequently observed with more or less distinctness similar results follow a similar mode of treatment, and the absence of such results where the gum has not been irritated by the pressure of the cotton, the conclusion, that the mucous membrane when irritated throws out a secretion capable of injuring susceptible teeth, follows as a necessary deduction. This conclusion will also be

justified by the results which often follow when the filling introduced into a cavity is allowed to project so as to keep up a state of irritation in the gum. The patient after a time returns with tooth-ache, and on examination we find that the tooth has decayed above the stopping in the immediate vicinity of the irritated gum. The irritation, if continued, may lead to the secretion of pus. But pus, when secreted by the mucous membrane presents the ordinary alkaline character of that fluid, and does not appear to exercise an influence upon the dentine.

The case as respects the lining membrane of the mouth is, however, not without a parallel. The mucous membrane of the bladder, when in a state of irritation, pours out a strongly acid secretion.

A disordered state, local or general, of the mucous membrane, must not, however, be regarded as the only source from whence may be produced agents capable of decomposing faulty enamel or dentine. For instance, examples present themselves in which the teeth rapidly decay in mouths free from any increased vascularity, local or general—free from adherent mucus about the teeth, and also from any sign of that fluid being either excessive in quantity or vitiated in quality. If in such cases the oral fluid be carefully examined, I believe it will be found that the saliva itself has at intervals lost its alkaline character, and become acid. Several patients (females) returning after a prolonged residence in India, have presented the foregoing conditions of the mouth. They have been pale, bloodless, and greatly debilitated, though not necessarily greatly attenuated subjects.

In speaking of the oral fluids as having constituents pos-

sessing sufficient activity to rob dentine of its phosphate of lime, we must not lose sight of the fact, that where teeth decay very slowly, and the disease arises in situations in which defective organization is very often found, an abundant supply of acid to produce the effect may be introduced with the food, or may find its way from the stomach.

Without going into the consequences produced by caries, when the pulp-cavity is laid open, the influence exerted upon the pulp when the disease is advancing towards it, may be noticed before the question of treatment is entered upon. With the advance of age, the area of the pulp-cavity becomes gradually diminished by the slow addition of dentine to that which was formed when the tooth was in a state of active growth; and this condition is still more strongly marked in those teeth which have been worn by mastication; indeed, in some cases the cavity is almost, in others perfectly, obliterated. In either case the effect is, as respects the contraction of the cavity, general, but the local development of dentine continuous with the pre-existing tissue, is very often coincident with caries. When the crown of the tooth is attacked, the pulp very commonly resumes its formative functions at a point corresponding to that towards which the disease is advancing, and adds as it were a patch, or plate, of new dentine (or secondary dentine, as it is commonly called), the tubular and intertubular substance of which is continuous with that of the older tissue, and thus the tubes of the two parts are continuous, although at the point of junction they are often marked by a slight dilatation. When the tooth is strengthened by additions made upon the walls of the pulp-cavity, in consequence of the tooth becoming weakened by disease

operating upon the outer surface, we have a remarkable example of the manner in which Nature attempts to remedy a defect. But the reparative efforts are not always productive of favourable results. In the place of additions being made to the pre-existing dentine by the calcification of the superficial part of the pulp, several, or even many, independent centres of calcification may be established within its substance. In some cases, we find numerous irregularly globular masses of dentine; in others, one or two nodules sufficiently large to occupy nearly the whole of the cavity. It seldom happens that the larger masses are developed from a single centre. They appear to have been produced by the aggregation and coalescence of a number of lesser globules. This secondary nodular dentine may or may not be adherent to the walls of the pulp-cavity; it is, however, more frequently free than attached, and in that case fails to answer the useful purpose of protecting the pulp from exposure.

Mr. Salter speaks of the calcification of the pulp when it occurs upon the surface, producing new dentine continuous with the older tissue, as extrinsic calcification, and the new tissue as dentine of repair. But when nodules are produced within the substance of the pulp, he proposes the term intrinsic calcification. The former he regards as a reparative process, the latter as the consequence of disease. If it could be shown that nodules of dentine, when produced within the substance of the pulp, are invariably the result of disease of the tooth, and that dentine, when added to pre-existing tissue in the manner described, is in no case the consequence of disease, and that the two forms of calcification do not go on at the same time, and the products become blended into one

mass, then the distinction drawn by Mr. Salter might be maintained with advantage. In order to ascertain whether the occurrence of isolated nodules of dentine is invariably coincident with the presence of disease, a number of perfectly sound molar teeth were removed from the jaws of subjects in the hospital dead-house, for the purpose of careful examination. In four cases out of five, nodules of dentine were found embedded within the substance of the pulp. They were not so numerous as the nodules are commonly found to be in the pulps of carious teeth, but the fact of their being present, however small the number, in sound teeth, at once invalidates the conclusion that intrinsic calcification is the consequence of disease. These forms of secondary dentine have, however, been long known. A notice of the calcification of almost the whole substance of the pulp in a sound tooth will be found in the *Medical Times* for September 26th, 1840, communicated by Mr. M. S. Ryding, Limerick.

Caries—Treatment.—The disease at present has been regarded as confined to the dentine and enamel only, and in entering upon the treatment, the same limitation will be observed. The exposure of the pulp and other complications will be subsequently considered.

In the treatment of simple caries two methods are employed. The removal of the diseased, together with the surrounding healthy tissue, to such an extent as to leave a perfectly smooth surface, constitutes one method; the removal of the diseased tissue, and the substitution of some indestructible material for the lost part, constitute the second method of treatment. In either case the diseased part must be removed, or at all events such portions of it as

have been softened by the abstraction of the phosphate of lime.

In selecting between these two operations, we must be guided in the first place by the depth to which the disease has penetrated, and by the situation in which it is established. If the disorganization has not extended into the dentine to a depth which greatly exceeds the thickness of the enamel, and either the median or distal surface of a tooth (especially of a front tooth) be the part attacked, the operation of excision may be performed with advantage. But if the teeth are irregularly placed, the advantages of this method of treatment may be either increased or diminished by the peculiarity of the case. Teeth when crowded together, will be improved by the operation if they have been attacked with disease on the lateral surfaces, but when a separation exists already, the widening of the aperture by the file will produce an unsightly appearance, without offering any advantage over filling the cavity.

The operation of filing is not confined to the simple removal of the affected portion of a tooth by the file. Not only must the diseased part be cut away, but it must be removed with such other portions of the surrounding parts of the tooth as will enable the operator to leave a perfectly smooth surface, and one which can readily be reached when the teeth are cleaned. Files of several degrees of coarseness, or cut, as it is called, are required, and of various shapes. Both these conditions have been carefully considered, and we can now find at the dental instrument makers almost an endless variety of the required forms. But should we fail in finding such a file as would best answer our purpose, a pattern may

be made in any soft metal, and forwarded to the file maker. It would be an endless task to describe every form of file which has been used in operating on the teeth, more especially as each operator will seek for himself such shapes as suit his own views, and are adapted to his own method of operating. The use of the file having been carried to a sufficient extent, the rough surface left by that instrument has next to be removed, and a smooth and polished one, free from angles or depressions, substituted. In the production of this surface pumice powder is used after the file is abandoned, and subsequently chalk, applied by means of a strip of linen or a piece of wood cut into a suitable shape.

The median or distal side of a front tooth is the situation in which the file is most commonly applied, and the operation will leave the dentine exposed to a greater or less extent. Now, if the rough or grained surface left by the file be allowed to remain, and be so situated that the food in mastication, or the tongue in its constant motion over the part, fails to remedy by friction the defective operation, we shall soon find the exposed dentine extremely sensitive, discoloured, and softened. Examples are sufficiently numerous in which a dividing file has been passed between two sound front teeth for the purpose of relieving lateral pressure. The division so produced has closed up, and the part placed beyond the influence of friction. In the course of a comparatively short time, each tooth the enamel of which has been cut through is attacked by decay; a cavity results, less favourable for plugging than would have arisen had the operation of filing been omitted.

Nature sometimes performs for herself an operation which

is analogous to filing when properly performed, both as regards its physical peculiarity and its results. The walls of a broad but shallow cavity produced by caries break down, the softened tissues are exposed to friction and rubbed away, till at last the hard dentine is reached; this becomes brightly polished, and endures for an indefinite time unaltered.

The frequent occurrence of unfavourable results has led many to regard with considerable distrust the operation of filing, and the distrust is justified when that instrument is used upon sound teeth for the purpose of relieving the lateral pressure of one tooth upon another. But we may see cases in which great advantages have resulted from the operation, and it will not be difficult to discover the conditions the observance of which has led to those advantages. In the majority of cases it will be found that, with the whole of the disorganized, a considerable portion of sound tissue has been cut or filed away, and the surface resulting from the operation placed within the influence of the food in mastication, and of the tongue. In order to secure these two conditions, it may be necessary to remove so much of a tooth as will interfere with its appearance. It is better, however, that the form should suffer slightly than that the whole tooth should be lost.

The file only has been spoken of, but instruments known as enamel cutters, or chisels, are frequently used in conjunction with the file. With these instruments the diseased part may, in many cases, be removed much more rapidly, and with less inconvenience to the patient, than with the file, and the surface will be quite equal to that produced by the latter instrument.

When operating upon an upper incisor, the anterior surface of the tooth should be as little encroached upon as possible, the removal of the enamel and dentine being confined to the median and lingual surfaces. Supposing the contiguous surfaces of two teeth to be affected, the interval between them produced by the operation should be wedge-shaped, the edge of the wedge being directed towards the lip, and the base towards the tongue.

If the bicuspids or molar teeth were subjected to a similar operation, the edge of the wedge-shaped interval would be directed towards the gums, and the base on a line with the masticating surface of the teeth.

There are certain cases of caries in which, although the diseased part might be removed by the file, its use would be injudicious. At all times the sensation produced by filing the teeth, to say the least, is very disagreeable; but in certain states of the teeth the procedure is attended with great pain, so much so that the operation cannot be properly performed. Again, when we find associated with caries a thickened and vascular condition of the gums generally, and more especially of those parts which pass between the teeth, together with an exudation of the thick ropy mucus to which I have already referred, the operation of filing will be attended with very doubtful success. If we filed out a small cavity, it is probable that in a short time another, equal to the extent of dentine exposed, would take its place.

The file and the enamel cutter have been spoken of in connexion with those cases which may be treated by operations in the performance of which these instruments only are used. But we shall have again to recur to them in connexion with

the operation of filling, and as the manner of using such instruments will then be described, it will be unnecessary to enter upon the consideration here.

In the treatment of caries, filling must ever be regarded as the great remedy by which the disease may be arrested, and the defective tooth restored to a state of efficiency. The operation consists in the removal of the disorganized tissues, and replacing them by a material fitting perfectly the cavity produced by their removal, and capable of resisting the chemical influence of the oral fluids, and the mechanical effects of the food during mastication.

The disorganized portion of the tooth is cut out, and the lost part is made good by an inorganic material.

There is perhaps no other operation performed upon the human body which is attended with the same unqualified success as that of filling teeth, for we not only succeed, in the great majority of cases, in arresting the further progress of disease, but we also replace the part which has been lost by an imperishable material, and render the organ as useful as it was prior to its becoming the subject of caries. It is, however, a great error to suppose that filling will, under all circumstances, permanently save the tooth, even in cases which at the time the operation is performed promise favourably.

There are those who are disposed to regard the decay of a tooth which has been filled as the result of want of skill or of care in the operator; such an opinion is perfectly untenable when the character of the operation is considered, in connexion with the tissues which are involved, and the various conditions under which disorganization may be effected. The very fact that caries has appeared in a tooth

demonstrates its predisposition to disease. We can, for the time being, arrest the disorder, but it may re-appear in some other part of the tooth, and may in fact commence a second time in the enamel and dentine in the immediate vicinity of the plug, which will then form part of the circumference of a new cavity. Such results will occasionally arise in the practice of those who use the utmost skill in their operations, and they will be seen still more frequently among the patients of those whose cry is infallibility. The ultimate success of an operation will in great part depend upon the skill with which it is performed, but it will not depend wholly upon the operator. There are other sources of failure than the assumed want of skill in operating, and such as are not under the control of the dental surgeon or of the patient.

In some mouths the majority of the teeth will contain plugs of various ages, ranging perhaps over a period of twenty or even forty years, all of them looking bright, and the contiguous dental tissue free from discoloration, the mucous membrane of the gum healthy in appearance, and free from adhesive mucus. In another mouth, again, in which there are many plugged teeth, treated by the same operator, we may find each plug surrounded by discoloured dentine, associated with a thickened and vascular state of the mucous membrane. With the lapse of time the decay indicated by the discoloration extends, and the plug falls out. Again, instances will be seen in which a number of plugged teeth, after standing without appreciable change for years, show signs of giving way—not, however, in consequence of the defective character of the operation, but in consequence of failure in the general health, and a concomitant vitiation of the oral fluids.

Attention has been called to the fact, that instances will occur in which the operation of filling fails to secure a permanent advantage, not for the purpose of depreciation, but in order that its value as a mode of treatment may be fully recognised and rendered independent of the injurious effects which the exaggerated expectation encouraged by some, and the want of proper confidence entertained by others, have a tendency to produce in the minds of those whose field of observation has been but limited.

The operation of plugging is divided into two distinct stages—the first of which is confined to the removal of the disorganized tissues and the production of a cavity of suitable shape; the second consisting in the introduction of the material used for making the plug. For the present the preparation of the cavity for the reception of the plug must receive attention, upon the proper performance of which the ultimate success of the operation will in great part depend.

In the treatment of a case, the first point for decision will be the extent to which the diseased dentine can be removed. The general rule is to cut out the disorganized tissue, until the walls of the cavity present the colour of healthy dentine; but there are exceptions to this rule. In the first place, the dentine may have become to a certain extent discoloured, and yet have retained its normal hardness. Again, the discoloration and even softening may have advanced so far into the tooth that the removal of the whole would endanger the exposure of the pulp. If the pulp be exposed during the operation, the loss of the tooth is to some extent endangered, consequently it is better

that a layer of discoloured dentine should be allowed to remain for the protection of the pulp rather than run the risk of sacrificing the tooth. Supposing that the walls near the orifice are strong and sound, it does not appear that the retention of a little slightly-softened dentine at the bottom of the cavity interferes seriously with the durability of the plug. The presence of any softened tissue at or near the orifice of the cavity must, however, be carefully guarded against, for the neglect of this precaution would be followed by the extension of the disease.

An exposed edge of disorganized dentine will allow solvent fluids to pass through it to the sound tissue, rapidly or otherwise, as the surface exposed is relatively great or small, and spreading from a single point at the circumference of a plug, the decay will by degrees encircle it with a softened and porous layer. This, though a sufficient, is not the only reason for attending carefully to the removal of all the disorganized tissues near the orifice of the cavity. It is next to impossible to produce a sound and solid plug the circumferential boundary of which is soft and yielding, and the difficulty would be still farther increased if the substance against which the gold is pressed be saturated with moisture. The retention of softened dentine, even in the bottom of a cavity, should, if possible, be avoided; but if it be allowed to remain both in the bottom and on the side of a cavity, the operation of plugging will be attended with but temporary advantage. The gold in such cases cannot be fully condensed either by direct pressure against the bottom or against the sides of the cavity by the process of wedging.

The first step of the operation is not, however, completed on

the removal of the softened tissue, for the resulting cavity would seldom present a form favourable for the retention of the plug. When the disease has penetrated to a short distance only, the removal of the decayed part would leave a mere concavity, the sloping sides of which would favour the escape of the plug when pressed upon one side only. It consequently becomes necessary, after the disorganized matter has been taken away, to proceed with the excision of more or less of the healthy tissue, until a cavity of suitable form has been produced. A cylindrical hole may be regarded as presenting the most advantageous form for the reception of a plug, but it is in a comparatively limited number of cases only that this regular figure can be obtained. A certain degree of approximation can, however, be generally reached, and the nearer the approximation the greater will be the facility with which the operation of plugging is performed, and the greater also will be the chance of producing a durable plug. In the molar teeth of the lower jaw the decay sometimes takes a crucial shape, and its excision will leave a cavity of similar figure. The course to be pursued in this case will be to remove all the angles at the central points where the arms of the cross meet, render the walls of the cavity parallel, and reduce the extremity of each arm to a semicircular figure. If the latter precaution be neglected, we shall have a series of minute terminal fissures into which it would be impossible to force the gold, and the operation, however carefully performed otherwise, would be followed by the establishment of a centre of decay corresponding to the extremity of each arm.

When the disease has advanced to a greater extent than it

is assumed to have done in the preceding example, the removal of the softened tissue will often leave a large cavity, the orifice of which is considerably contracted, owing to the enamel, and perhaps a thin layer of the subjacent dentine, having resisted the influence of the destructive agents more successfully than the more deeply-seated tissue. It might be thought that the overhanging of the sides of the orifice would favour the retention of a plug, and the assumption would perhaps be justified if it were practicable to introduce a perfectly solid plug in a cavity so shaped. Unfortunately it is extremely difficult to force a filling under a projecting ledge so as to produce even a moderate degree of solidity in the part which occupied the angle; and the consequent imperfection is still further increased when, in condensing the surface, considerable pressure is directed in a line from the top to the bottom of the plug, the effect of which is to depress the gold and carry it away from the under surface of the projecting margin of the cavity. The plug may have a very satisfactory appearance when finished, but in a comparatively short time evidence of failure will be discovered. That portion of the tooth which overhangs the plug being but imperfectly supported from within, will break down, moisture will find its way around the plug, decay will be re-established, and if the operation is not repeated, the tooth will be lost.

In order to avoid unfavourable results arising from the foregoing cause, the overhanging edges must be cut away, if not sufficiently to produce rectilinear walls, yet to reduce the angles to moderately curved surfaces. The walls of a cavity may bulge outwards or inwards, but anything approaching to receding angles or sharp corners must be

avoided. It may be necessary to repeat, that the pressure applied by the filling instruments condenses the gold only in the line in which the force is directed. The metal is condensed beneath the instrument, but it does not spread to any appreciable extent in the lateral direction, unless a perforation be made by the instrument, and the direction of the force changed; and in no case will the condensation extend to any considerable distance. For instance, if gold be pressed into an acute angle, it will become hard upon the surface pressed upon by the instrument, and also upon the surfaces which have rested upon the sides of the cavity which at their point of junction form the angle, but the gold which lies in the angle will remain porous. If the instrument used were in each case sufficiently sharp or pointed to fit into the terminal point of the cavity, of course the gold could be forced into it, but in practice it would be extremely inconvenient to employ such an instrument, and under the circumstances of an angular depression extending around the cavity, impossible.

When the cavity is very shallow, the general rule with respect to the sides being parallel may be deviated from with advantage. It will be well to make the bottom comparatively flat and the sides rectilinear, or divergent from without inwards. It may happen, however, that this form cannot, owing to the condition of the tooth, be produced, that the convergence will be from without inwards, giving the outline of an inverted cone. To render a cavity so shaped capable of retaining a plug, one or two shallow grooves should be cut around the circumference of sufficient depth to hold the gold firmly in its place when forced into them in the operation of filling.

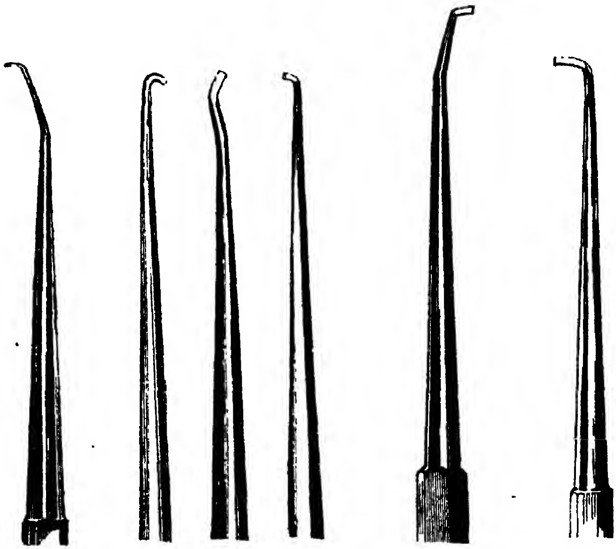
It will be unnecessary to enter further into the form of cavities until we consider the operation of filling in special cases; but there are other points in respect to the procedure which may be considered in connexion with cavities generally.

The strength of the walls of a cavity is a very important subject. It is useless to leave a portion of a tooth standing which a trifling degree of force will at any time break down, and thus expose the plug; and it is worse than useless to leave that which will give way during the operation of filling, and thus perhaps endanger the whole tooth. An unwillingness to interfere with the appearance of a tooth not uncommonly induces the operator to attempt the preservation of a part which eventually gives way, and necessitates the performance of a second operation under circumstances less favourable than obtained on the first occasion, and the tooth is left in a more unsightly condition than it would have been had the fragile portion been freely cut away in the first instance. The absolute strength required will vary with the position which the tooth occupies in the mouth. In a molar tooth, which has to sustain the full force of mastication, the walls of the cavity must be composed of enamel and dentine, with a considerable thickness of the latter; whereas, in front teeth a much thinner layer will be found sufficient. Indeed, in incisor teeth the enamel alone, if the extent be limited, is sometimes sufficiently strong, when supported by a plug, to endure for many years. The colour of the gold may show through at the point where the dentine is entirely absent, and yet there may be sufficient strength in the enamel for the maintenance of the plug, and of its own structure.

There is yet another point in the formation of a cavity to which attention may be advantageously directed.

The character of the margin of the orifice is scarcely less important than the shape of the cavity itself. As a general rule, the plugs which are surrounded by enamel are more durable than those inserted in cavities the margins of which are partly formed by dentine or cementum. It is consequently desirable to preserve if possible the former tissue, and to remove the dentine at the margin of the orifice in such a manner as will allow the gold to come in contact with

Fig. 130. [1]



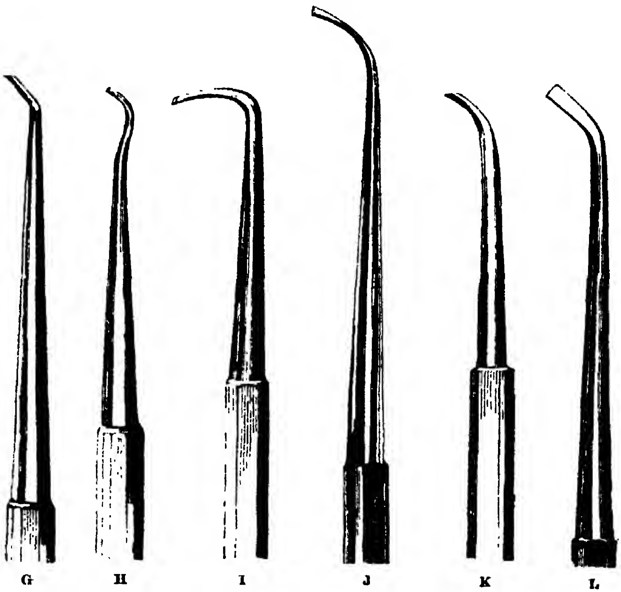
A B C D E F

the enamel, so that it shall cover over and protect the dentine. Where the circumference of a plug is bounded by

[1] Figs. 130, 131, show some of the most useful forms of excavators.

strong enamel, as on the masticating surface of a molar tooth, the undulating character of what we may call the top of the wall, is unimportant; but should dentine form a part or the whole of the boundary, as it will do when the disease is situated on the mesial or distal side of a tooth, then it will be necessary to reduce the margin of the orifice to a flat and smooth surface.

Fig. 131.



Several forms of instruments are used in preparing cavities for the reception of plugs, but they come under one or other of two heads, viz., cutters and drills. The one class will include what are commonly called "excavators" and enamel cutters, while in the other will be ranged drills of various forms, and burr-heads, as they are called.

It will not be necessary to do more than make a few general observations upon the manner of using the instruments employed in removing the diseased tissues. The forms which have been figured may be taken as those most commonly used, but the minute variation in size and shape required from time to time generally leads to a great accumulation of this description of instruments. The operator should be able to make for himself excavators to suit any peculiar case which may arise. There is, however, one property which should be possessed by all, whatever the shape or size of the instrument. It should be made of good steel, and kept perfectly sharp. A blunt instrument tends to prolong an operation which is always disagreeable and sometimes very painful. With a perfectly sharp excavator the diseased tissue is quickly removed, and with a comparatively slight amount of discomfort. A few rapid and well-directed strokes of the blade, and the softened tissue is cut away, and although a proper form has yet to be given to the cavity, the subsequent steps of the operation are seldom productive of as much discomfort as attended the removal of the softened tissue.

Under the head of drills are included those instruments used in the preparation of cavities for the reception of plugs, which cut by a rotatory motion.

The rose-head is very serviceable in reducing to a cylindrical form the ragged opening of a small cavity. The file-like character of the surface enables the operator to cut away with readiness the enamel which has become weakened by the softening of the subjacent dentine. Six or eight sizes of heads should be at hand, and each may form a separate instrument made in pinion wire, or from a seven-inch length of square or round steel. But it is perhaps better to have a set

of blades fitted to a common holder, and the crutch-handled rose-head and drill-holder will be found to present many advantages. The crutch rests between the thumb and fore-finger, or between the latter and the second finger, leaving the tips of the thumb and finger free to rotate the shaft of the instrument, while pressure is made upon the crutch. (Fig. 132.)

For some years I have used this instrument with the form of the cutter modified. Instead of producing a spherical head the steel has been allowed to retain an uniform cylindrical figure, and teeth have been cut, not only at the extremity, but for some distance up the shaft. (Fig. 133.)

With this construction of cutter we secure all the advantages of the rose-head, accompanied with an additional amount of strength in the part

Fig. 132. (1)

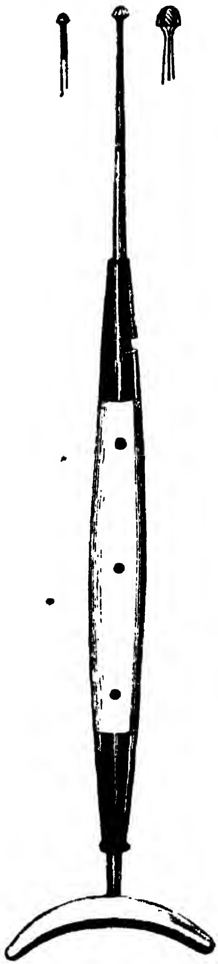


Fig. 133. (2)

(1) Showing three sizes of rose-heads, the central one placed in the crutch-handled stock or holder.

(2) Modified form of rose-head.

corresponding to the neck of the latter; also the capability of enlarging an orifice through which the point has entered by the cutting surface of the shaft.

Fig. 134. (1)

The rotating file or rose-head is very serviceable when the enamel requires removal, but for cutting the dentine an ordinary drill presents many points of superiority. It cuts more rapidly, can be more easily made sharp, and its course can be more readily directed than the rose-head, owing to the greater amount of pressure required to bring the latter into effective operation. Drills of various size and shapes may be mounted in the crutch-handled stock shown in a preceding figure, or the drill and shaft may constitute one continuous length of steel (Fig. 134). The latter arrangement possesses some advantages. The shaft is held, when rotated, between the thumb and finger; and as but little pressure is required to make the blade cut, the direction and the rate of progress which the instrument makes can be very readily felt. The operator will find advantage in having various sizes of this instrument, the form of the points being also varied.

We shall however occasionally meet with cases in which the dentine has assumed such a high degree of sensibility that the removal of the decayed part cannot be borne. The patient flinches from the slightest touch of the instrument, whether it be an excavator or a drill. A minute quantity of arsenic

(1) Drill made from a cylindrical piece of steel, with the point chaptered from each side.

placed in the cavity, and retained for a few hours, will render the part perfectly insensible to pain. But the action of the arsenic is not always limited to the surface of the dentine. It finds its way to the pulp, and occasions death of that organ—a condition which is soon followed by discoloration of the whole crown of the tooth, and very frequently by the supervention of alveolar abscess. There are other agents capable of reducing the exalted sensibility of dentine, but while they do not involve the same amount of risk as the use of arsenic, their action is much slower, and the remedy has consequently to be applied over a much greater period of time.

Camphorated spirits of wine, frequently applied upon a fragment of cotton wool; tannin, mixed with a solution of gutta-percha and chloroform into a thick paste, will, if introduced into the cavity, in the course of a few days reduce the sensibility sufficiently to allow the operation to be performed. Solution of mastic, introduced on cotton wool, is often beneficial. In fact, any form of temporary filling, if introduced with sufficient care to exclude the saliva, will soon be followed by a subsidence of the sensibility of the tissue.

The substances in general use for filling carious teeth are of two distinct classes. In one the ingredients are mainly derived from the vegetable kingdom; in the other from the inorganic world. Those belonging to the first division are regarded for the most part as temporary remedies, useful only when more imperishable materials cannot, from the condition of the tooth, be used. Many substances may be enumerated as applicable for temporary purposes. The following are those most commonly used: solutions in alcohol or ether, of gum sandarach, anami, mastic, copal, or dama.

Either of these, when reduced by the solvent to the fluidity of treacle, may be introduced into the diseased tooth upon cotton wool. The spirit, or ether, soon leaves the gum, which entangled and adherent to the wool, forms with the latter a tolerably hard mass, capable of lasting several days, if applied under favourable circumstances. As a general rule, however, such fillings should be renewed once in twenty-four hours, otherwise they become offensive, and when in that condition do more harm than good. In place of the cotton, powdered lime or chalk may be substituted, in which case the solution of gum resin is mixed with the powder in such proportions as to make a mass of the consistence of ordinary putty. Whichever be used, the cavity should be dried with cotton wool, or what is better, amadou, before the introduction of the mass.

In making a selection from these forms of temporary fillings, we must be guided by the objects to be attained. Supposing the tenderness of the tooth is the barrier which precluded the adoption of a metallic plug, the mixture of chalk and varnish will be found the most durable, and also the most agreeable to the patient. But very commonly we require that the gum should be pressed away from the margin of the cavity, in which case the filling must be allowed to project from the orifice.

Under these circumstances the use of cotton wool will be found preferable. There is but little choice between the gum resins enumerated; either, in a state of solution, will answer sufficiently well. I give the preference to gum sandarach, as being more free from taste than the others, if the copal be excepted. Ether being the solvent of copal,

renders the solution rather less manageable than those made with alcohol. The rapidity with which the ether escapes, however well the bottle in which it is kept may be corked, very soon reduces the solution to a condition unavailable for dental purposes.

Gutta percha, with which some mineral substance, such as powdered silex or glass, has been incorporated, makes a remarkably good temporary filling, capable of lasting for some months. In using this compound, a piece of suitable size must be taken, and warmed over a spirit lamp until the whole mass is softened. The cavity having been dried, the heated gutta-percha is introduced, and the superfluous portion removed with a warm instrument. Care must of course be taken that the filling is not too hot, otherwise its introduction will be attended with pain. But, on the other hand, it must be sufficiently warm for the surface to be a little sticky, or it will not adhere to the surface of the cavity. This form of filling is particularly useful in those cases in which the teeth, although generally free from pain, will not bear the pressure required for the introduction of a metallic plug—a condition which will commonly pass away in the course of three or four months, if the cavity be sealed up with the gutta-percha. Instances are not uncommon where, after the introduction of a gold filling, the tooth is so painfully sensitive to changes of temperature, that the patient is in dread of either hot or cold beverages, or even of drawing cold air through the mouth. If the gutta-percha be substituted, the inconvenience passes off, and the tooth will, at the end of a few months, bear the re-introduction of the gold without any of the preceding discomfort.

A new compound for filling teeth has recently been produced. A mortar is formed by mixing oxide of zinc with a solution of chloride of zinc. The compound hardens very quickly to the density of good plaster of Paris, and must be introduced into the tooth without loss of time. Although cases have occurred in my own practice in which this filling has been unaltered after the lapse of six months, it cannot, with our limited experience of its durability, as yet be regarded otherwise than as a temporary remedy.

The second class of substances used for filling carious teeth are altogether metallic. Substances capable of enduring in the mouth without undergoing any material change, and hence are regarded as fitted for permanent plugs. Of these we have two kinds: alloys, in which mercury forms an important ingredient; and pure metals.

It may, I think, be assumed as a settled point, that for dental purposes a pure metal, such as gold or even tin, is preferable in all respects to any mixture of metals at present known. But there are cases in which the one can be used while the other cannot. The American writers on dental surgery have urged every possible argument against the use of amalgams, and have even gone so far as to pass rules for the expulsion of those members from their dental societies who would not pledge themselves to avoid the use of mercurial fillings. Yet there are teeth, the conditions of which are such, that gold as a filling cannot be used with any chance of success, but which if plugged with a good amalgam will last for years, and be perfectly effective during the whole of that time. Common sense will, I think, decide the question whether it is better to have a tooth filled with amalgam, or to lose it at once. It has been urged that the mercury

used in making the alloy will salivate the patient. I have never seen a case in which this result was produced, and I think we may fairly conclude that the instances are so extremely rare that they need not influence our practice.

It must, however, be borne in mind that I am not advocating the use of amalgams where pure metals can be used, but I do contend that the former are extremely useful where the employment of the latter is prohibited. Take as an example a tooth the crown of which has been hollowed out to such an extent that the introduction of a foil filling would break down all that remains above the surface of the gum, yet in which the pulp has been calcified and the tooth is free from tenderness. Such a tooth if left to itself will soon crumble away, but if carefully filled with amalgam it may last for years.

Many examples may be found in which these kinds of filling have preserved the teeth in a state of usefulness for long periods, the use of gold at the time the operation was performed, from some cause having been interdicted. It is true the teeth may be stained by the filling, but the presence of a stained tooth is preferable to vacant gums, more especially when situated at the back part of the mouth, and subservient only to the purposes of mastication. This objection, however, can at the present time be scarcely said to hold good. The amalgams now in use do not stain the substance of the tooth as the older preparations did—a property due, I think, to the presence of more or less copper in the compounds formerly employed.

It is not uncommon to meet with cases which support these views in respect to the occasional use of amalgams. Patients sometimes request that such fillings may be removed

and gold substituted, but more frequently an officious operator urges the necessity of refilling teeth which have been judiciously and effectively treated. One of two results follows; either the teeth remain as useful as they were before the substitution of gold for amalgam, or what is very common, the teeth are rendered tender by the operation, and the patient, after more or less suffering from inflammation about the roots of the refilled teeth, is obliged to submit to the extraction of organs which, had they been allowed to remain undisturbed, would in all probability have continued serviceable for years.

I have in my own mouth two wisdom teeth which, three years since, were so much decayed that it seemed hopeless to attempt their preservation. They were extremely tender when brought in contact with hard food, such as biscuit or crust of bread, and felt as though they would ache before many weeks had passed. I removed as well as I could the carious portions, of course very imperfectly, and filled them with amalgam. These teeth have since that time given me no discomfort: hence I have a right to consider that the use of amalgam has enabled me to retain two teeth which would otherwise have been removed or have fallen into disuse three years ago.

Till within a comparatively recent period it was customary to reduce into filings the ordinary silver coin, mercury was added, and the compound worked up in a mortar or in the palm of the hand until the whole became reduced to a stiff paste. The superfluous mercury was then squeezed out either by pressing the mass between the thumb and finger or in a fold of chamois leather. After this manipulation the

compound is placed in the tooth, and in the course of a few hours becomes quite hard. Although this form of amalgam is bright when introduced, yet in a short time the surface becomes black and the whole body of the tooth by degrees assumes a dark grey colour.

A series of amalgams have been long known as Sullivan's cements, but the composition of the several qualities offered for sale has not been described. They are sold in large pill-shaped masses, and the operator is directed to crush in a mortar a sufficient quantity for the case under treatment; and to place the mass in an iron spoon, which is to be held over the flame of a spirit-lamp until globules of mercury appear upon the surface of the fragments. In the heated condition the compound is returned to the mortar, and rubbed until reduced to a paste. It is afterwards squeezed in chamois leather, to separate the excess of mercury, and is then ready for use. These amalgams possess the same objectionable qualities as the one already noticed, but in a less degree, and are therefore preferable.

Precipitated palladium, when rubbed up with mercury, forms an amalgam which does not stain the tooth although it becomes in the mouth of a dark grey colour. The process of uniting the two metals is a little tiresome. The mercury rolls about in the finely-divided palladium, and at first shows no disposition to unite; but when the combination commences it proceeds rapidly, and is accompanied by the evolution of considerable heat. After the metals are incorporated, no time must be lost before the mass is introduced into the faulty tooth, as the process of hardening proceeds very rapidly. This alloy in the soft state is very plastic,

and will take an extremely delicate counterpart of any surface upon which it is pressed, much more so, indeed, than any other form of amalgam with which I am acquainted. The preceding compounds when pressed in the soft state between the thumb and finger, impart a very peculiar grating sensation, a property which the palladium amalgam does not possess.

Dr. Evans introduced, several years since, a compound of cadmium, tin, and mercury, which at first appeared to possess many advantages over all other similarly-constituted alloys. When perfectly set, the colour resembled that of tin, and the degree of hardness was about equal to that metal. These conditions presented great advantages over the hard, brittle, and dark amalgams formerly used, and the new compound was consequently very generally adopted. It was, however, soon found that the cadmium, when used as a filling for teeth, became subject to rapid oxidization. The mass lost its tin-like softness, and became friable, while those portions in contact with the tooth were converted into the yellow oxide, giving to the surface against which it rested a brilliant yellow or orange colour. Hence it happened that the use of cadmium as a basis of dental amalgams was no sooner adopted than abandoned. Attention had, however, been drawn to the subject, and attempts were made to find a compound which would neither oxidize nor assume an objectionable colour.

Mr. Arnold Rogers published, in 1850, an account of an amalgam which he had used for several years with success.(1) It was composed of one part of gold, one part of silver, and seven parts of mercury, and required heating before use much in the same manner as Sullivan's cements. This pre-

(1) Pharmaceutical Journal, vol. ix. p. 402. 1850.

paration was not subject to discoloration, but I am told by Mr. Rogers there was some difficulty in obtaining uniform results as regards the degree of hardness of the plugs, and the time required for the hardening when used in the mouth. These difficulties led him to discontinue its use in favour of other formulas which have since been introduced.

Messrs. Ash, of Broad-street, vend an alloy, supposed to be composed of gold, silver, and tin, to which mercury is added when required for use. And Mr. Robertson, of Birmingham, at about the same date, published a formula, containing similar ingredients. It is composed of "gold, one part; silver, three parts; and tin, two parts." The metals, which must be perfectly free from impurities, are melted together, and run into an ingot, and afterwards reduced into filings.(1) To these mercury is added at the time of using, and the quantity required is equal in weight to the filings. Whether the above preparation is identical with that sold by Mr. Ash, I cannot tell; but the properties of the two are very similar, each being far superior to the amalgams formerly in use, both as regards colour and the incapability of staining the teeth.

But, although the tissues of the teeth are not discoloured, yet even these preparations become a little dark in hue after they have been some weeks in the mouth. Moreover, they are hard and brittle; hence a preparation capable of retaining the physical properties which Dr. Evans's amalgam possessed at the onset, would be an improvement upon those sold by Messrs. Ash and others.

When required for immediate use, the requisite amount of

(1) Pharmaceutical Journal, vol. xi. No. 12. 1852.

filings is placed in a mortar, or in the palm of the hand; mercury is added, and the two are rubbed together until a stiff paste is formed. This should be washed, either with alcohol, or (according to Mr. Rogers) with compound spirits of ammonia. The first portion of fluid will be deeply coloured, but after one or two repetitions the amalgam will cease to impart any stain to the liquid. The mass may then be dried in a napkin, and after squeezing out all the superfluous mercury, is ready for insertion into the faulty tooth.

In conducting the operation, the cavity should be freed from moisture, and the amalgam may then be pressed firmly in, care being taken that the cavity is thoroughly filled, while none is allowed to project—a precaution that must be especially observed where the gum lies over the margin, and thereby conceals the edge of the orifice. The plug will become perfectly hard in the course of a day, and should, if opportunity is offered, be filed smooth and polished, together with the margin of dentine or enamel by which it is surrounded.

The kind of surface assumed by amalgams in the process of hardening will be considered in connexion with the surfaces presented by those parts of gold fillings which lie in contact with the walls of cavities.

Before leaving this subject, a peculiar effect upon the dentine, produced more fully by the older amalgams than by those at present in use, may be noticed. The blackened tissue against which the amalgam has rested for a lengthened period, is commonly found to be extremely hard, much more so than healthy dentine, and much more so than that which is subjacent. It is often difficult to cut away the discoloured and indurated tissue, but when this is effected the instrument

readily operates upon that which is next presented. This peculiar property renders amalgams useful for temporary plugs where the teeth are extremely sensitive and fragile, and especially in those cases where other temporary fillings are not available.

Gold adapted for filling teeth is now presented to us in two distinct forms: the one form being gold leaf or foil, the other sponge, or, as it is now more commonly called, crystal gold—a spongy mass composed of minute crystals of pure gold.

Gold foil is produced by beating into thin sheets a perfectly pure metal. The sheet when prepared for dental purposes is usually about four inches square, and is numbered in accordance with its weight. Thus we have Nos. 4, 5, 6, 7, and 8, the number in each case indicating the weight of the four-inch sheet. The gold leaf of commerce is altogether a different article. In order to produce a leaf sufficiently thin for gilding, it is necessary to introduce a certain amount of copper, without which the metal when greatly reduced will not leave the vellum, between sheets of which it is beaten.

Seeing that a perfectly pure metal is required by the dentist, it might be thought that any gold-beater who would obtain the crude material in a state of purity could produce a foil suitable for filling teeth. Experience has, however, shown that it is very difficult to manufacture an article fulfilling all the required conditions. The state of purity may, of course, be obtained, and is a mere matter of expense. But we require that the foil shall be tough and soft, and latterly two other conditions have been recognised.(1) The

(1) **In a paper by Dr. Arthur, published in the Dental News L[illegible] and subsequently as a monograph, these two conditions of gold foil are pointed out, and the manner of using the adhesive kind is fully described**

foil must present either a high degree of adhesiveness, or it must be in the highest degree non-adhesive. In the one case, if two strips are pressed together they should become inseparably united: in the other, they should, on the removal of the pressure, readily part. The value of these different properties will appear more clearly after the manner of using the foil has been described.

There are several methods of using gold foil. In one the leaf is cut into strips, which are afterwards folded into ribands of suitable length and breadth, or twisted loosely into ropes.

Fig. 135. (1)

The riband or the rope is introduced into the cavity by an instrument having a wedge-shaped extremity, in such a manner that each fold shall have one extremity resting on the bottom of the cavity while the other projects slightly from its orifice. When we are unable to introduce any more foil, a sharp cutting wedge-shaped instrument is forced into the centre of the metal, which by the act of perforating presses the gold forcibly from the centre towards the circumference of the cavity. The hole thus produced is filled by folding in vertical layers a further quantity of riband or rope. The operation of perforating and refilling is repeated until the gold becomes so dense that the instrument cannot be made to enter. The success of the proceeding will depend upon the character of the foil employed, that which is destitute of adhesive property being alone suitable when the fore-

(1) **Gold foil, loosely twisted in the form of a rope.**

going manner of operating is adopted. Had the operation been conducted with adhesive foil, great difficulty would have been encountered in carrying the folds to the bottom of the cavity when the operation approached completion. Each fold would adhere when it came in contact with the gold already impacted, and if force be employed the instrument would cut through the riband, leaving the orifice narrowed, while the lower portion of the cavity remains undiminished; and unless great care were taken the operation would terminate in the production of a plug very hard on the surface, and soft or porous in the interior—a character of filling presenting a good appearance, but capable of saving the tooth but for a short time. The hardened surface will give way, and the plug either become depressed or it will fall out. It might be supposed that in filling a small cavity, which in the general sense of the term, though it equals the size of the whole tooth cannot be very large, the gold foil would be compressed throughout the whole mass of the plug by pressure made upon the external surface. Experience, however, shows that this effect cannot be produced. The foil, whatever its character, becomes condensed immediately under the instrument into a thin hard scale, which arches over and protects from pressure that which is below. This condition obtains in all the forms of gold available for dental purposes. In no case can a moderate sized plug be introduced and compressed as a mass—to be effective, the pressure must be applied consecutively to each of the many portions (and these must be small portions) of which the plug is gradually built up. But although we cannot depend upon producing a sound plug, unless it is formed by the

gradual addition and compression of small pieces of gold, yet there is a great difference in the qualities of foil in respect to the manner in which they are influenced by pressure. Thus a sheet of the non-adhesive, when made into a ball by rolling between the fingers, may be compressed and adapted to the sides of the cavity with some degree of uniformity throughout the mass; but if adhesive foils be similarly treated, we shall find that the surface against which the plugging instrument has been pressed is condensed into a hard layer, while that which lies next to the cavity has been relatively but slightly acted upon, and probably, instead of adapting itself, has turned away from the surface of the tooth at several points towards the instrument, and become loose in the cavity.

With the non-adhesive foil, a mass after introduction is readily applied to the walls of the cavity, which becomes contracted to an amount corresponding to that of the metal added, until at last the whole space is occupied by gold. But each mass so added, although closely adapted to that already introduced, will preserve its own identity, and on the tooth being broken up, may be separated from those with which it has lain in contact. On breaking up the plug, it will become apparent that the component masses have been held together by a system of packing within a circumscribed space, not by the adhesion to each other of the several portions of which the plug has been built. It is very necessary that this point should be fully understood.

If the operator proposes using the non-adhesive foil, he must proceed upon the principle of packing, and the layers of foil must pass from the bottom to the orifice of the

cavity; but should he adopt the adhesive foil, the steps of the operation will be different. The first point to be gained is to fix a mass of foil in some part of the cavity. To accomplish this the wedge-shaped instrument may be advantageously changed for one which has an obtuse extremity, broken up into a series of small ridges and points. If there is no part of the cavity so formed that a portion of foil can be wedged into and retained in it, the proposal has been made that a small hole should be drilled in some convenient part, into which the foil may be forced. It is, however, seldom necessary to adopt this proceeding. By using a second instrument in the left hand, we may in difficult cases retain the gold in position while it is condensed by the right hand. Having once firmly fixed the first part of the plug (which may be composed of one or of several portions of foil), the subsequent steps of the operation are comparatively easy: small portions of foil, either in the shape of small balls, or short strips or ropes, are pressed firmly with the point of the instrument upon the gold already impacted in the cavity, care being taken that the instrument is applied to every part of the surface, and that the gold added is distributed pretty evenly over that upon which it is placed. One portion is added after another, each one being thoroughly consolidated upon its predecessor until the cavity is perfectly filled, and the plug projects slightly from its orifice. Now if the foil has been good, and the operation carefully performed, we shall not have a plug made up of a series of small masses wedged one between another, and retained together by the walls of the cavity, as in the preceding example; but we shall have a solid mass of gold, which, if the tooth be broken, will

present a cast of the cavity from which it has been liberated.

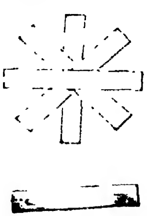
The use of the term solid as applied to gold plugs, requires qualification. I believe it is quite impossible to produce with foil, or indeed with any form of gold, a plug having a degree of solidity equal to that of an ingot of pure metal. The resistance to pressure of which the tooth is capable would prove insufficient for the production of absolute solidity. Again, the dentine, against which the metal is pressed, is not sufficiently hard to afford the resistance which would be required. For the sake of testing the working qualities of specimens of gold, I have been in the habit of clamping a slip of ivory, having cylindrical perforations, upon a block of the same material. After filling one of the holes the lip is removed, and the lower surface of the plug is presented for examination. In no case have I seen a foil filling in which minute fissures could not be discovered by the aid of the microscope. However, sufficient density can be produced to give the plug the appearance and the feeling of perfect solidity, and to ensure durability. More is not required.

There are other methods of commencing the operation. Foil may be rolled up into a ball of sufficient size to fill the cavity when introduced without compression. When in position, the gold is perforated with a sharp-pointed conical instrument, of sufficient size to force the foil against the circumference of the cavity. In filling up the central aperture, the sides also of the filling should be forced down. At this stage of the operation we shall have a dense plug immovably fixed upon the floor of the cavity, and rising up the sides to within a limited distance of its orifice. To com-

plete the filling, the careful superposition of layers of adhesive foil is alone necessary. In this manner a plug may be built up in a cavity, two sides of which have been lost, supposing the two remaining walls are strong. For example, a large fissure running across the masticating surface of a bicuspid, and cropping out upon the mesial and distal sides of the crown of the tooth, may be effectively filled. Assuming the foil to possess the adhesive quality, difficulties, should they arise, may depend either upon the gold already in the cavity having been insufficiently consolidated, and so yielding before the instrument and the superadded layer, instead of affording an unyielding surface, against which the latter can be pressed, so as to ensure perfect metallic contact. Or the failure may arise from the surface of the gold having become wet, either from the saliva or the condensation of the breath.

It is very desirable that moisture should be perfectly excluded from the cavity, whatever form of gold or other material may be employed in making a filling; but when adhesive gold is used, the necessity for its exclusion becomes imperative.

Fig. 136. (1)



There is yet another method of manipulation by which a perfectly satisfactory gold plug may be made. It consists in

(1) **Gold foil, folded into ribands and arranged into the shape of a star.**

arranging, in the form of a star, short lengths of ribands of foil, in the manner shown in Fig. 136. A number of such stars should be placed upon a piece of vulcanized caoutchouc. A blunt-pointed plugging instrument, on being pressed upon the centre of the star, will sink into the indian-rubber, and the gold will be folded upon the point of the plugger, and in this condition may be carried to and pressed into the cavity, leaving the radii of the star projecting; a second and a third star are taken up in a similar manner, and forced into the cavity. When the centre has become full, the projecting ends or radii may be pressed with a fine-pointed instrument into the cavity near its circumference. If the instruments have been well chosen in respect to a gradual diminution of size, an extremely dense plug will be the result.

The Americans were the first to propose the formation of cylinders made by folding the foil into ribands, and then

Fig. 137.

rolling the ribands round a fine broach. (Fig. 137.) The cylinders are made a little longer than the depth of the cavity they are intended to fill, and introduced one after another until the space is thoroughly occupied. A wedge or a trocar-edged instrument must then be forced into the gold at any point where it can be made to enter; and the hole so produced is filled by a cylinder of suitable size, or by a star of gold foil.

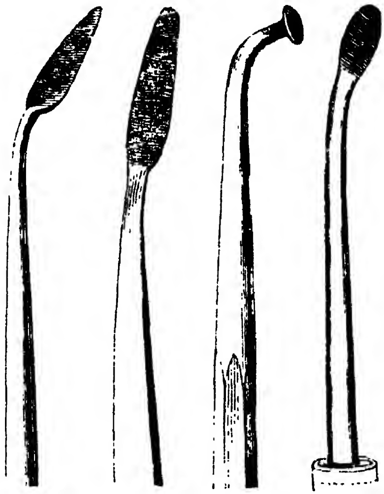
In the foregoing descriptions it is assumed that the operation of filling is proceeded with from beginning to end upon

the same plan. In practice, however, it will often be found advantageous to embrace several methods in the same plug.

The cavity by one method or another having been filled, and the gold allowed to project slightly from the orifice, the next step towards the completion of the operation will be to reduce the surface of the plug and the margins of the cavity to the same general level, allowing a slight degree of fulness to the central portion of the plug.

This part of the operation will readily be effected by a suitable file, after which the plug may be carefully examined

Fig. 138. (1)

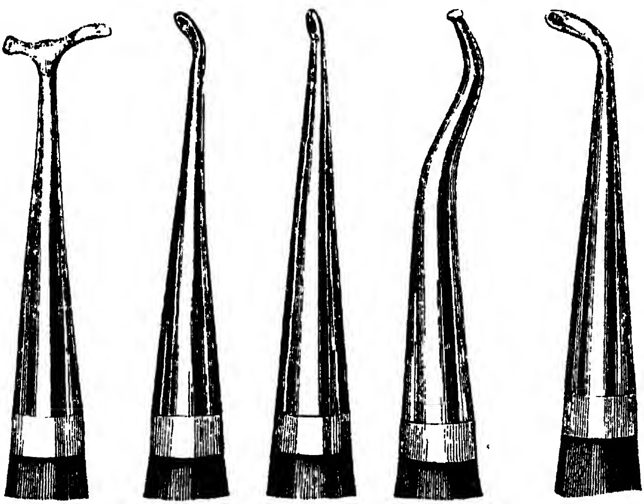


with a sharp-pointed instrument, and should any part be found sufficiently soft to allow of penetration, the aperture must be enlarged and additional foil introduced, after which

(1) Showing several useful forms of file for reducing the surface of a plug.

the file must be again used to reduce any inequalities, and to remove the impression left by the instrument. We have now to remove, by means of pumice powder or fine silex, applied upon a strip of soft wood or upon a piece of tape, the marks left by the file, and subsequently the surface may be polished with chalk, applied in the manner adopted with the pumice. It will be found that the burnisher will facilitate the steps of the operation, if it be used after the file has been abandoned,

Fig. 139. (1)



and again after the application of the pumice powder. Indeed, in many cases the firm application of the burnisher will assist in the consolidation of the plug, and in the production of an

(1) Showing a series of burnishers, in which are included some of the most useful forms of the instrument.

even surface, before we have recourse to the file, and prior to the saliva gaining access to the surface of the filling.

Within the last few years a new form of gold adapted for filling teeth has been produced by chemical means. The metal is thrown down from a state of solution in a more or less crystalline form.

Mr. Makins was, I think, the first who procured sponge or crystal gold, as it is now called, with a view to its being used for dental purposes. His preparation consisted of minute octahedral crystals, connected loosely together by fibres, which at parts exhibited a crystalline character, the whole forming a spongy mass of dead gold colour. The sponge under pressure became consolidated, in which state it could not be distinguished from solid metal. Additional pieces of the sponge, if added to that which had already been condensed, on the employment of moderate pressure became adherent. This adhesive or welding property rendered the gradual formation of a plug, solid in all its parts, a matter of but little difficulty, and in the absence of a distinct recognition of the adhesive properties of certain samples of foil, the new gold appeared to offer great advantages, and seemed likely to supersede the use of foil in certain characters of plugs. I have seen, from time to time, fillings which were made with Mr. Makins' first batch of sponge, and up to the present period they have remained unaltered. A description of the gold, with the manner of using it, was published by myself.

Mr. Makins did not enter upon the manufacture as a commercial matter. The subject having attracted notice, others attempted to produce a similar preparation, but the

results were so unfavourable, that for a time the use of the sponge gold was abandoned.

Subsequently Mr. Barling, of Maidstone, gave his attention to the subject, and introduced a sponge gold not altogether dissimilar to that which Mr. Makins produced. It is formed mainly of octahedral crystals and indistinct fibres.

Soon after the production of sponge gold in this country, the attention of transatlantic practitioners became directed to the subject. Many experiments there as here were made, with very questionable success. Ultimately, however, a very beautiful preparation was made by Mr. Watts, and this is, I believe, the only form of sponge gold used in America. We know it as Watts's American crystal gold, the valuable properties of which have been very strongly put forward by Dwinelle and others in the American dental journals. The gold comes to the hand of the operator in the form of light spongy cakes, readily compressible between the thumb and finger. Several degrees of density are produced, but the character of the gold is otherwise the same. By the aid of the microscope we are enabled to see that the American differs in its structure from the English sponge gold. Each is crystalline, but while the latter consists of crystals of the form normal to the metal, the former is made up of beautiful foliaceous crystals closely resembling in general appearance the leaf or frond of a common fern. They have considerable superficial extent with very slight thickness, and lie together greatly entangled and interlocked.

In the earlier samples a considerable amount of amorphous gold was entangled amongst the crystals, and in some cases oxide of gold was present in a small amount. These imper-

fections have been remedied, and the reguline condition is obtained by all the manufacturers. Very recently samples of sponge gold prepared in Paris have reached this country.

Whatever may be the form of crystal assumed by the metal, the manner of treatment in the production of a plug will be pretty much the same. The sponge must be torn up into small fragments, of a size suitable to the cavity into which they are to be introduced. Each fragment on its introduction must be thoroughly condensed before we proceed to add another. Any attempt to introduce a large amount of sponge and then consolidate it as a whole will terminate in the production of a plug very hard on the surface and very soft in the interior. Such results were common before the use of sponge gold was properly understood. The plugs looked very bright and solid on the surface, but very soon their disintegration commenced, and upon examination the cavity operated upon, instead of containing a plug of solid metal, was found to be occupied by a brown, more or less coherent mass, the surface of which could be readily broken up by the finger-nail.

In order to command the best results in the use of the crystal gold, four points require attention.

The gold must have been recently manufactured, or recently annealed, in order that the adhesive property shall be fully pronounced. The plugs must be built up of small fragments, each one being perfectly consolidated before another is added. The metal must be preserved from the contact of moisture until the plug is formed. And appropriate instruments must be used in performing the operation. The neglect of either of these conditions will be followed by an unfavourable result.

Sponge gold on exposure to the atmosphere soon loses its peculiar adhesive quality, and becomes quite unmanageable; instead of welding together under the stopping instrument, it falls to pieces, and all attempts to make additions to that which is already consolidated are unsuccessful; on this account it is desirable to anneal the metal where any doubt exists as to its condition. By the process of heating, the adhesive property is restored, even though the temperature to which the gold is exposed falls short of a red heat. But to whatever extent the welding property is produced, the presence of moisture will at once render it unavailable. The metal, from its porous condition, absorbs like a sponge, and instead of consolidating under the pressure of the instrument, works up into powder. We must therefore guard against the admission of the saliva, and also protect the tooth under operation from the expired breath, which being charged with moisture will, if the metal be of a lower temperature than itself, deposit upon it a sufficient amount of fluid to interfere with the adhesive property of the gold.

The instruments fitted for operating with crystal gold differ from such as are required for the introduction of non-adhesive foil, but in most respects resemble those best adapted for adhesive foil.

The working end, instead of terminating like a wedge, is more or less flattened, and cut up into a series of small points or ridges, in the formation of which it is necessary to exercise some little care. The more perfectly formed are the ridges or quadrilateral cones, the more easy will be the management of the gold. After a little use the edges or points become blunted, and require restoration.

An instrument which presents a working surface of some little size, will be found convenient for introducing the gold into the cavity; but so soon as we have compressed the gold firmly against the wall of the cavity, or upon that which has been consolidated, a smaller instrument must be worked over

Fig. 140. (1)

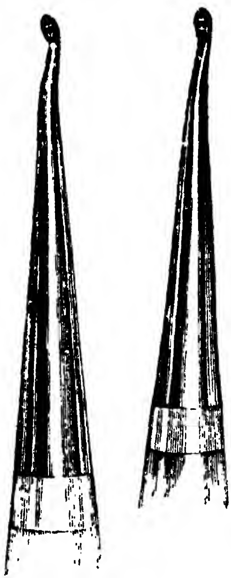


Fig. 141. (2)

the surface, and ultimately a still smaller one; indeed, a point may be exchanged for the chequered working surface. By the repeated use of a pointed instrument, after a new piece of gold has been added to that which had been previously introduced,

(1) Figs. 140, 141, show forms of instruments for introducing and compressing sponge gold.

the solidity of the plug is ensured, and a surface favourable for the addition of still more gold is produced.

The character of the surface to which further additions of gold are required is of considerable importance. In the first place, it must be perfectly clean, and free from moisture of any kind; and in the second, it must be rough, either from the impressions of the one or the many-pointed instrument.

Let the surface be made wet by the tongue, or smooth by the burnisher, and no more gold will adhere until it is again rendered perfectly clean and reduced to the rough condition previously mentioned.

Much has been said in praise of crystal gold, owing to the readiness with which the lost half, or even two-thirds of a tooth can be restored by building up in metal a copy of the absent part. When out of the mouth the half or the whole of the crown of a tooth may be reproduced in sponge gold; but in the mouth the operation of restoration is by no means so easy: it is not impossible, but it is generally impracticable. There are few patients who could keep the mouth open for a sufficient length of time, and when they can, the tooth gradually cools down to a lower temperature than the expired breath, and precipitation of moisture upon the metal is the result. The operation may be suspended for a short time, if on recommencing it the gold be wiped dry, and the surface scraped or filed, so as to ensure a clean surface. It is seldom, however, that the result is perfectly satisfactory when the procedure is interrupted; indeed, the restoration of any considerable amount of the crown of a tooth is rarely attended with lasting success. A few show-cases may be produced, but the operation is too

tedious, and the ultimate result is too uncertain, to admit of general application.

In instituting a comparison between gold foil and crystal gold, the microscope may be called into requisition with advantage. If plugs be made in perforated pieces of ivory (in the manner already alluded to) with the various forms of crystal gold, we shall find that the surface which has been pressed upon, and has rested against the ivory, is made up of crystals, the forms of which have been unaltered by the pressure. Their presence in this situation indicates a certain amount of porosity, and it is due to the dentine not offering sufficient resistance to interfere with the crystalline character of the metal. Had the hole been in metal instead of ivory, the inserted plug would have presented a much greater density upon the lower surface; or had the cavity been lined with enamel, a similar advantage would have been gained. In practice it is very frequently necessary to plug a tooth from which the whole of the diseased tissue cannot be removed; hence a substance softer than healthy dentine forms the surface, the resistance offered by which will be quite incapable of producing condensation of the gold to the extent obtained where the disorganized part is wholly removed: consequently, if crystal gold be used, the enclosed surfaces of the plug will be imperfect, they will be capable of absorbing moisture, and may after a time be broken down with very slight force. On the other hand, when the cavity is shallow, with the bottom hard, and the orifice surrounded by enamel, perfectly satisfactory results may be obtained. In those cases where decay has commenced upon the labial surface of the front teeth, the crystal

gold may be used with great advantage. The plug should be made to project, and then be filed down to the level of the surrounding surface of the tooth.

The attainment of absolute solidity in a gold plug made in the mouth, is not possible. If crystal gold be used, the microscope will show a certain amount of porosity; if foil be employed, it will show the presence of fissure in the peripheral surface of the plug. Now, if moisture finds its way to the surface of the fomer, it will spread over the whole circumference of the plug; but in the latter it will be confined to the minute fissures situated at distant intervals over its surface. After using crystal gold for some years, and examining very closely into the results, I have come to the conclusion that it is inferior to foil for the construction of that portion of the plug which rests against the dentine. But if the operation be commenced by lining the cavity with foil, the central portion of the plug may be advantageously made with crystal gold. By thus combining the two forms of gold, plugs may be produced, the density and impermeability of which cannot be surpassed.

Form of Pluggers.—Before entering upon a description of the manner in which the operation of plugging is performed on the different members of the dental series, attention may be with advantage drawn to the general character of the instruments used. It may with justice be stated that the forms are infinitely varied. Each operator has his own patterns, often executed by his own hands, and to his present stock he makes an occasional addition, in order to meet the requirements of a special case, for the treatment of which his cabinet contains no suitable instrument.

The comfort of the dentist in operating, and the comfort of the patient also, to some extent depend upon using instruments with suitable handles and shafts, without reference to their working extremities. My own experience leads me to prefer a compressed oval handle made of wood, the dimensions of the oval being an inch and a half in the greater, and one inch in the lesser diameter. The oval gradually gives way to the cylindrical form, where the shaft or metallic portion of the instrument begins, at which point there should be a perfect equality of size and shape. The metal should gradually taper, until the working extremity or blade is reached. By the adoption of this form of handle and shaft all irregularities of surface are avoided, which if present, however ornamental they may appear, would be liable to inconvenience the lips of the patient, or irritate the hand of the operator. In respect to the shapes of the terminal portion of the instrument, many pages might be occupied in describing the varieties of form, and even then the account might perhaps be deemed incomplete. In entering upon the special operations, occasion will be taken to mention the forms which the author has found most useful for the treatment of the case under consideration. But the manner in which many of those forms have been determined may be described, as it is a course the adoption of which will prove advantageous to those who feel that the instruments with which they are supplied do not fully meet their expectations. Let an approved handle be selected, and into it fit a shaft made of block tin, reduced to the size and length of a perfected steel instrument. The tin may be bent into any shape, and adapted to the case under treatment.

By this method a perfect model is produced; the dentist or the instrument-maker can make an exact copy, which, if it does not prove useful, will at all events accord with the views entertained by its designer. The author usually keeps a few instruments completed excepting at the working ends, in order that a new form may be produced in a few minutes should one be determined on in the manner described; very many have in this manner been produced, some of which have proved extremely useful, others have been used but rarely, and others again have proved quite worthless. The plan of proceeding has, however, been attended with so much success that its adoption may be recommended, not only for determining the forms of plugging instruments, but also for excavators, &c.

Some advantage will be gained by attending to the length of instrument: supposing the dilated portion of the handle to be placed in the palm of the hand, and the fingers closed upon it, the metallic portion should pass but a short distance beyond the extremity of the thumb when the latter is extended. It may then be used with the thumb or the fore finger resting against the tooth under operation, or upon a contiguous tooth. With this rest, the force brought to bear upon the plug can be more steady and stronger than it would have been had the length of the instrument been too great to admit of the use of the thumb or finger as a guard.

For the convenience of description, the shaped terminal portion of the shaft will be divided into two parts. The one designated the blade, the other, the terminal edge or working point or surface of the instrument.

The most simple form will be that in which the blade is in

a line with the shaft; then will follow those having the former part bent at an angle with the shaft. The most complex and at the same time the most useful forms are those in which the blade is bent in a spiral direction to the extent of an eighth or quarter of a turn, the coil being more or less open and irregular, to suit the views of the operator or the peculiarities of the case. The succeeding illustration will give an idea of the form alluded to, although it must not be regarded as showing an instrument of general utility, the commencement of the curve being somewhat too abrupt. The working edge, if sponge gold or adhesive foil be employed, must be cut into ridges or sharp-pointed cones, a process which may be effected by a sharp dividing, or a three-sided file, but it can be more readily accomplished by a tool made for the purpose. Such a tool is readily constructed by taking an ordinary reeded scaulper, softening it, and converting the longitudinal ridges into teeth by making transverse cuts with a file. When re-hardened to the temper of a file, it will cut upon softened steel a series of sharp edges, which on changing the direction of the cutter may be converted into points.

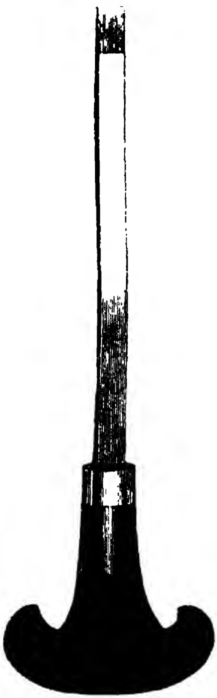
Fig. 142. (1)

Treatment of Simple Cavities in the Front Teeth.—As the teeth are usually in close apposition, it becomes necessary to resort to means capable of producing a sufficient amount of se-

(1) A plugging instrument, the blade of which has a spiral curve, adapted to introduce and condense gold foil into cavities situated on the mesial or distal surfaces of the front teeth. A pair, a right and left instrument, will be required.

paration to allow of the introduction of instruments. The end may be gained either by the introduction of strips of caoutchouc or of compressed wood between the teeth, or we may cut away the faulty tooth. The selection of means must depend upon the state of the tooth to be operated upon. If the decay has a considerable superficial extent, it will be well to cut away the lingual surface of the tooth with the chisel (Fig. 143), in such a manner as shall leave a V shaped division between the teeth, without interfering with their external appearance. If the superficial extent of the disease be limited, it will be well to avoid cutting into the tooth, as we should be sacrificing sound tissue. The requisite separation may be obtained by the insertion of india-rubber between the affected and the contiguous tooth. In some cases a sufficient interval will be produced in twenty-four hours, while in others a much longer time may be required.

Fig. 143. (1)



The next step in the operation will be the removal of the disorganized tissues. The facility with which this and the subsequent stages of the operation are performed will depend to a considerable extent upon our means of placing the patient's head in a suitable position. Formerly an easy

(1) Chisel-shaped instrument for removing the enamel and cutting down the affected surfaces of carious teeth.

chair with a tolerably high back and a moveable cushion was considered sufficient, and even now many practitioners, having from long habit accustomed themselves to overcome the difficulties of position which it entails, give the preference to such a chair. During the last few years all the appliances relating to the practice of dental surgery have undergone considerable improvement, and operating chairs have received their full share of attention. The most recent, and I think by far the best, is that manufactured by Mr. Betjeman. It is capable of moving noiselessly into any position which the patient can support. It is perfectly firm, and is unobjectionable in appearance. The position of the head will from time to time require notice, but the subject of chairs need not be further discussed. In operating upon the superior incisors the head should be thrown back to an extent sufficient to place the alveolar line in a vertical position, and the patient raised to a level with the chest of the operator; the mesial surface of the front teeth will then be seen without necessitating the maintenance of an unpleasant stooping position.

Before proceeding to remove the decayed tissue, the condition of the gum with respect to the diseased tooth should be considered. In many cases we shall find the free edge vascular, and descending below the upper margin of the cavity, and perhaps curled into it. When in this state it will be next to impossible to operate without wounding the gum; blood will then flow for some time, and perfectly obscure the cavity. Formerly the patient would have been sent away, with directions to force cotton wool saturated with a solution of mastic between the teeth, renewing it from time to time until

the gum became forced up out of the way. I believe we owe the following ready and effectual method of at once getting over the difficulty to our American brethren. If a jaw from which the soft parts have been removed be examined, it will be seen that a triangular space separates the necks of the teeth, the base being formed by the alveolar process, and the apex of the triangle by the convergence of the mesial and distal surfaces of the contiguous teeth. The interval so produced (Figure 89) is occupied by the gum, and our object is to prevent its bleeding, and at the same time to move it from the margin of the cavity. To accomplish both purposes it is necessary to take a strip of soft wood, such as willow or plane, and cut or file it into a triangular rod. When reduced to a suitable size, introduce it by steady pressure between the teeth, taking care that the basis of the triangle corresponds to the edge of the alveolar process; by this means the gum will be pressed up against the latter part, the bleeding will be stopped, and the cavity in the tooth fully exposed to view. The introduction of the wood will occasion a little pain at the moment, but it soon gives way to mere uneasiness. When teeth have been gradually separated by caoutchouc, the presence of the wedge tends to keep them steadily fixed, and thereby renders the operation of plugging less painful than it would have been had the teeth remained unsupported. The ends of the wood will of course be cut off close to the lingual and labial surfaces of the teeth, and the removal of the carious dentine may then be accomplished without interruption.

If we are operating upon the mesial surface of the left central incisor, the tooth may be held by the index finger and

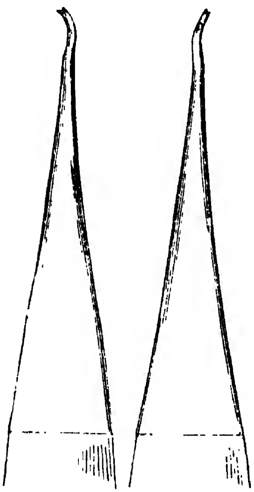
thumb of the left hand, the arm having been passed round the head to the left side. In using the excavator, it must ever be borne in mind that the pulp, though less in size, corresponds very closely in shape to the tooth itself, and although it may be, and often is, altered in shape by the calcification of the part towards which the disease has proceeded, yet the cutting instrument must be used with caution after we have advanced to a certain depth into the dentine; for should the pulp be wounded, the destruction of the tooth may be endangered. Rather than run an obvious risk, it will be better to leave a little discoloured tissue at the bottom of the cavity. From the walls and from the floor of the cavity, on its labial and lingual sides, it may be cut away, as in the latter situation we shall escape the pulp by proceeding behind or in front of it.

Having shaped the cavity in accordance with the directions given when treating upon the subject generally, the part should be cleared of all extraneous matter by directing upon it a stream of warm water by means of a syringe. The cavity should now be wiped dry with cotton wool or tissue paper, and its shape very carefully examined. Should any doubt exist as to a proper form having been produced, a little warm wax or gutta percha may be pressed into it, and a cast obtained. By this simple procedure we shall often discover that had a plug been introduced, the chance of its preserving the tooth for any length of time would have been but slight. Supposing it be found that the walls of the cavity are generally divergent from within outwards, the defect must be remedied. Small hoe-shaped instruments will be found suitable for reducing to parallelism the labial and lingual

walls; and a drill, carefully directed so that it shall not approach too closely upon the pulp in the neck of the tooth, will reduce to a proper figure the upper wall of the cavity. After feeling assured that the cavity has acquired a form favourable for the retention of a plug, it must be thoroughly washed out, and subsequently made perfectly dry.

Steps must now be taken for preventing the access of moisture: a roll of cotton wool, or a small napkin folded into a riband, should be placed between the gums and lips, and brought round upon the palate behind the front teeth. Its position may be maintained by the index and second finger. The character of gold suitable for the case having been determined upon, and a sufficient quantity arranged upon the operating table within reach of the right hand, its introduction may be commenced, the patient having been previously requested to breathe through the nose.

Fig. 144. (1)



If the cavity be not very large, foil arranged in the stellate form will be found to work advantageously. Two or three stars may be taken up on the point of the instrument and pressed towards the upper wall of the cavity; one after and within the other. The arms of the stars should then be folded inwards, and the whole

(1) A pair of instruments, right and left, the blades having a slight spiral curve, suitable for introducing foil into cavities in the front teeth.

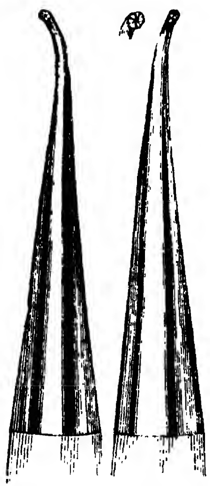
compressed thoroughly against the upper part of the cavity. Some little care is required at this stage of the proceeding, otherwise the gold on becoming condensed will begin to roll. The disposition to move from one part when it is pressed against another part of the cavity is generally produced by neglecting to compress the whole gradually and with uniform force. If the centre of the plug be consolidated while the circumference remains porous, the latter part will turn away from the tooth towards the instrument, and on pressure being applied to any point of the circumference, the mass of gold will turn or roll up from the cavity at the opposite point. Having recognised the manner in which a difficulty may arise, we have to consider how its occurrence may be avoided, or if present, how it may be overcome. The objectionable condition may be avoided by passing the instrument over the whole surface of the gold with a light hand, repeating the operation with gradually increased force until the whole is equally consolidated. But should the foil show a disposition to roll, we shall do well to remove it and recommence the operation, or to take an instrument in the left hand and hold down one part of the circumference while the other is compressed. The use of two instruments in the manner already alluded to is not unusual where adhesive foil is employed.

After thoroughly condensing the foil in the upper part of the cavity, the completion of the plug is comparatively easy. If the adhesive foil be used, the operation may be pretty rapidly perfected by adding short strips one after the other, compressing each consecutive piece upon the gold already introduced, taking care that in making the folds the duplicatures do not

fall short of the walls of the cavity, otherwise the plug will be hard in the centre and soft in the circumference.

Should non-cohesive foil be preferred, the same method with respect to filling the upper part of the cavity first, may be adopted; but in the subsequent proceeding it is necessary that the folds of the rope or riband should pass from the bottom to the orifice of the cavity. To effect this, an instrument with the working extremity terminating like a wedge, will be found the most serviceable form. The cavity having been filled, a sharp wedge or point, or what I think is still better, an instrument brought to a point by four champfers, thus producing a point and four divergent edges like a trocar, should be forced into the centre of the plug. The gold by this treatment is forced from the centre towards the circumference of the cavity, and without any tendency to displace the plug. The hole made by the perforator must be filled by the further addition of gold, which may be introduced with instrument in hand. When perforations can no longer be made, unless by using an amount of force that would endanger the walls of the cavity, an instrument with a flat face should be carefully worked over the whole surface of the plug. Recourse must now be had to the file. All gold which projects beyond the

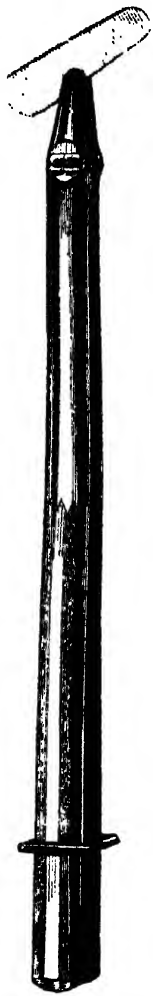
Fig. 145. (1)



(1) A pair of instruments, right and left, adapted for compressing plugs in the mesial or distal surface of front teeth, or for adding adhesive foil or sponge gold to the surface of an unfinished plug.

margin of the cavity, more especially that which is directed towards the gum, should be cut away, the indentations produced by the filling instrument filed out, leaving the surface of the plug perfectly free from irregularities, and on the same level as the surrounding tooth. The file may be followed by a strip of narrow tape, which after wetting has been loaded with pumice-powder or finely-powdered silex; an end being held in each hand, it should be drawn across the surface of the plug with a steady and moderately quick motion, and the friction continued until the file marks are removed from the surface of the plug, when chalk may take the place of the pumice. This amount of care in finishing a plug may perhaps be thought unnecessary, and the opinion may appear to receive support from the fact that some roughly-finished plugs last for many years without undergoing deterioration. But on a close examination into the character of the cases it will be found that the disposition to decay was not actively pronounced, and that the walls of the cavities were strong in every part. Had these characters been reversed, it is probable that in place of finding the plugs we should have heard that front teeth had been plugged some years ago, but that the fillings fell out in a short time, and that

Fig. 146. (1)



(1) Showing a pair of forceps for holding fragments of a dividing file at any angle that may be required for operating upon the median or distal surface of the anterior teeth.

these, with other teeth which were then diseased, gradually decayed away down to the level of the gum.

The immediate object in filling a tooth is to perfectly exclude from the cavity all extraneous matter, fluid or otherwise, and at the same time to leave a surface upon which mucus or minute particles of food cannot readily adhere. If the surface of the gold be left rough these indications are not fulfilled; food and other matter will collect, and necessitate the frequent use of the tooth-pick, which falling from time to time into the inequalities of the gold, eventually disturbs the filling. There is another advantage resulting from finishing with care the surface of a plug, and it is this: after the outer and harder part has been filed away, and the surface of the plug and the contiguous surface of the tooth reduced to the same level, we not uncommonly find that the plug is soft at some point, and admits of being perforated. The discovery of a defect having been made, a remedy must be found, even though its application may necessitate the removal of the gold and the recommencement of the operation. For to leave the plug pervious to moisture will be to endanger if not to ensure the further injury of the tooth. Unfortunately the fault is very commonly in the worst possible position, both as regards its effect in exposing the tooth to further disease, and its capabilities of amendment. That part of the cavity nearest the gum is necessarily the first to receive the gold, which, unless it be compressed before the introduction of the foil in the lower portion of the cavity, will, from the difficulty with which the distant part is subsequently reached, remain in a porous condition. But owing to the form of cavity usually produced by caries upon the distal and mesial sides of the

teeth, there is some little tact required to perfectly consolidate the upper, prior to the introduction of the lower portion of the plug. And we consequently find that the defects are most commonly situated at the upper margin of the cavity. If there be sufficient space between the teeth to admit an instrument, perforations may be made and additional gold introduced, but if the space be too contracted to allow of the satisfactory completion of the plug, it will be far better to commence anew.

A failure will, however, sometimes depend upon the character of the foil, which although perfectly good may be unsuited to the method of manipulation employed. Take, for example, the results of the following experiments, with leaves of foil taken from the same book. The foil employed had been prepared from crystal gold, reduced to four-grain sheets by beating in the usual manner. Although annealed from time to time during the process of reduction, it had not been submitted to heat after the final beating. The condition was therefore that of unannealed foil.

Several sheets were folded and cut up into short strips for the purpose of using in the stellate manner. In working it was found to be adhesive, but at the same time very brittle, and consequently required unusual care in introducing it between the teeth, otherwise portions broke off and fell into the mouth. Another sheet was torn in six or eight pieces, and rolled up between the fingers into as many small balls. These were introduced one after the other into a lateral cavity, with a small instrument having a slight spiral curve near the point. The centre of the ball was first pressed lightly into the cavity, and the edges subsequently turned in, and then the whole was thoroughly compressed. During the

operation the gold went down before the instrument into a very solid condition, but there was not the slightest tendency to turn up on one side when the other was pressed down, or to roll in the cavity. The gold filed freely, and when completed the plug presented a most satisfactory appearance.

From the same book a leaf was taken and rolled into rather firm balls, which were subsequently annealed. Under this treatment, although the adhesive quality was brought out more strongly, each ball, instead of going down dead before the instrument, had a tendency to turn up and clog the orifice of the cavity. Another leaf was annealed first, and then rolled into balls, which on trial proved superior to the annealed, but inferior to the unannealed balls.

From the same book two leaves were taken; one was annealed, and after division into thirds, twisted into three loose ropes; the other leaf was divided, and rolled without annealing. The latter showed a tendency to break to pieces and waste, while the former packed and adhered, the one fold to the other, with great readiness, and produced an extremely good plug.

The foregoing results have been brought forward to show that different samples of gold, though each perfectly good of its kind, may require different methods of manipulation in order to produce the best results. And they have been mentioned in connexion with cases of defective operations upon the incisors, because the front teeth require delicate treatment, and because there is good reason for supposing that the defects are often consequent upon the manner of use being ill suited to the particular sample of foil employed. Had the use of the stellate form of the unannealed leaf been persisted in, the plugs would have

crumbled; and had the use of the annealed balls been continued, the plug would have been with difficulty restrained from rolling in the cavity; moreover, the force required for its consolidation would in many cases have been greater than the incisor teeth are able to bear without endangering the bursting outwards of the labial wall of the cavity. There are few who have not seen a crack run across the enamel, perhaps in more directions than one, just as the operation was about to be completed.

Instances will occur in which the surface of the plug is good, and the circumference solid, excepting at the upper part near the labial surface of the tooth, a situation reached with some difficulty by the plugging instrument; and even then the imperfection is not discovered until the file wounds the gum, and a little blood steals in, and renders apparent a line, in the course of which the gold has not been forced into contact with the surface of the cavity.

These remarks have been made, not with the view of deprecating the use of annealed adhesive foil, but in order to draw attention to the necessity of observing great care in the construction of plugs when that form of gold is employed, and also for the purpose of showing that although a sample of foil may not answer the expectation of the operator when used in one manner, yet that it may be perfectly satisfactory when a different method of introduction is employed. Even the degree of hardness to which the balls are rolled or the ropes twisted, will influence the facility with which they are respectively used. The degree of heat to which the metal is submitted in annealing will also exert a considerable influence in determining the manner in which it can be most effectively ma-

nipulated. It would, however, be very difficult to enumerate every circumstance that may arise in connexion with the use of the different forms of gold employed in plugging teeth, and to give a detailed description of the methods of overcoming every difficulty that may present itself to the operator. The task would be almost endless, and if accomplished, would not even then relieve the dentist from the necessity of making himself practically acquainted with the subject by means of carefully-conducted experiments, both in respect to the materials used in the formation of plugs, and the instruments employed in conducting the operations.

A considerable space has been given to the manner of plugging cavities on the mesial surfaces of the left central incisors. The description will, however, apply equally to operations performed upon the distal surface of the right incisors, and to those situated on the distal surface of the corresponding teeth of the left side of the mouth, excepting only that the head should be turned towards the operator, instead of from him. The left hand, too, will be somewhat differently placed. When it becomes necessary for the patient's face to be directed towards the operator, the fold of napkin placed under the lip and behind the teeth may be retained by the thumb in the latter, and the index finger in the former situation.

It has been assumed that the teeth have been separated by means of india-rubber, or cut away on the lingual surface, without materially interfering with the part of the tooth exposed to view. But it may happen that the labial has been encroached upon by disease, while the lingual surface is comparatively uninjured. In that case the gold may be introduced from the front, leaving the whole of the back part of the tooth

standing. By the adoption of this plan, more even of the front of the tooth may be retained than though the firm, strong labial wall of the cavity had been reduced. For with the three sides of the cavity strong, the fourth may be preserved, although too weak to stand unsupported by the plug, the firmness and the retention of which will be sufficiently secured by the upper, the lower, and the lingual walls of the cavity. In conducting the operation, however, great care must be taken to avoid injuring the weak part; and it will be found expedient to introduce the foil in small portions, making each piece firm before the succeeding one is added; for should an attempt be made to consolidate the whole plug by perforating the central part of the mass, the weaker wall of the cavity will give way, and thus frustrate the object of the operation.

Cases will arise in which the disease has so far injured the tooth, that instead of finding one, all the walls excepting the upper are rendered too weak to admit of the application of sufficient force for the introduction of foil. Either the tooth must be sacrificed, or some soft stopping material must be used. Amalgams will render the tooth dark in colour, and cannot, therefore, be employed. The insertion of gutta-percha and silex, known as Hill's or Jacob's Stopping, is not open to this objection; and I do not know that in situations where the material is exempt from any great amount of friction, it is less durable than the amalgam. Many cases have occurred in which a gutta-percha plug has been perfectly sound at the end of two years, and presented all the indications of lasting for a much longer period. After all, the preservation of a tooth injured by disease to the extent under consideration is at best but

very uncertain. A hard crust, a fragment of bone, or a particle of grit in the food, on striking the tooth during mastication, may break down the walls of the cavity, and liberate the plug.

Caries may attack either the labial or lingual surface of the incisors, and necessitate the adoption of remedial treatment. Natural depressions in the enamel are not uncommonly found on the lingual surface of the incisor teeth, and it is in such situations that disease usually establishes itself. The cavities which result are generally of a very simple kind, and do not require any special description.

When the development of the enamel has been defective, cavities may be produced by disease in those parts where the natural defect is most strongly pronounced, whether situated on the lingual or labial surfaces of the teeth.

If submitted to treatment at a tolerably early period, the hole is usually characterized by a greater breadth than depth, and the shallow walls slope outwards.

The cavity, after the mere removal of the disease, may be compared to a saucer—a form incapable of retaining a plug with any degree of certainty. The first step in the proceeding must be the reduction of the walls to a vertical position by the use of a small but sharp excavator; and it will be well, when the cavity is very shallow, to produce a slight degree of under-cut. In selecting the materials for forming a plug, foil and crystal gold may be taken with advantage. Three or four thicknesses of foil, sufficient to line in an even layer the surface of the cavity, should be first introduced; small fragments of sponge gold may then be added, and thoroughly compressed one after the other, until the resulting plug

stands higher than the general level of the tooth. After removing the superfluous gold with a file, the surface of the plug should be examined with a sharp-pointed instrument, and any defect made good. This having been done, and the instrument marks filed out, the surface may be further improved by rubbing it with water of Ayr, or a slip of Arkansas stone, together with the surrounding enamel, should that be rough and broken in character. The operation will be completed when the surface of the gold has been polished, either by the use of chalk or the burnisher.

Another description of cavity in the front teeth remains to be noticed. A narrow transverse slit, produced, I believe, in the first instance, by the tooth-brush, is sometimes found immediately above the terminal edge of the enamel, deep in the centre, but cropping out on either side, with the walls diverging outwards. To reduce such a groove into a form for receiving a plug, the upper and lower walls must be slightly under-cut, and at the two extremities the groove should be deepened by the use of a drill so as to form a cavity. If the operation be properly conducted, the groove or slit will be converted into a trough, the sides and ends of which will, if not under-cut, at least be perfectly vertical. The operation of filling may be conducted in the same manner and with the same materials as in the preceding example.

In the treatment of cavities in the canine teeth, the directions which have been given in respect to the incisor teeth are equally applicable, both as regards the manner of operating and the materials used.

Treatment of Simple Cavities in the Bicuspid Teeth.—Any part of the crowns of the bicuspid teeth may be attacked by

decay, but the mesial and the distal surfaces are the situations in which it is most frequently developed. Supposing the mischief to have occurred on the mesial surface of the second bicuspid on the right side of the mouth, the operation will be commenced by cutting away the enamel from the mesian edge sufficiently to expose the cavity, and to admit of the introduction of instruments employed in the subsequent stages of the operation. The radiate direction followed by the enamel fibres must be borne in mind, otherwise the removal of that tissue will be attended with greater difficulty and greater inconvenience to the patient than necessary. The most suitable instrument is the flat chisel-shaped enamel-cutter, the edge of which, on commencing the operation, should be applied in a direction parallel to the course of the alveolar line, and gradually changed to a rectangular position with the disappearance of the part undergoing removal. The excision of the carious tissue will now be effected without difficulty; and having advanced thus far, it will be advisable to introduce the wooden wedge between the teeth in the manner described at page 380. The gum having been pressed up against the alveolus, the cavity may be reduced into the required form without fear of embarrassment from a wounded vessel. Care must be taken to remove all the affected tissue from the upper part of the cavity. This may be accomplished with a drill, but the position of the pulp must be borne in mind, for instruments of this character, when in good order, cut rapidly, and if a proper direction be not observed, the pulp-cavity will be opened. In producing parallelism of the sides of the cavity, the hoe-shaped excavator will be found very useful, and several sizes and forms of these should be at

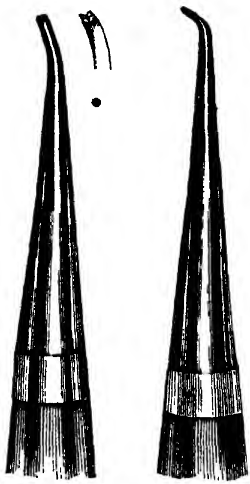
hand, some of which are constructed to cut by a drawing, others by a pushing motion. If this part of the operation has been conducted with success, an oval cavity will have been produced, the walls of which converge slightly from within outwards, more especially the upper wall, the margin of which will be covered by the wedge, thus producing a shallow cavity, a temporary side being formed by the wood. The head of the patient should be thrown back into the position similar to that described as the most convenient for operating on the front teeth. Instructions having been given in reference to keeping the mouth open, to breathing through the nose only, the teeth and gums should be wiped dry. After placing a fold of linen between the lips and gum, and another on the lingual side of the tooth, the cavity should be thoroughly dried with tissue paper or cotton wool, or any other convenient material. The thumb and fore-finger will be employed to keep the folds of linen in place, and to raise the lip out of the way. If the flow of saliva is very abundant, a slip of adhesive plaster[1] resembling Court-plaster, may be placed upon the lingual and labial surfaces of the gums, and allowed to extend a short distance over the tooth. After being held in position by the linen, it adheres firmly to the gums, and perfectly excludes the saliva from finding its way between the teeth. A sufficient quantity of gold having been prepared, its introduction may now be commenced. It will be desirable to have a square piece, composed of some eight or ten folds,

(1) The plaster, and the method of using it, were described be ore the Odontological Society, and the account was published in the first volume of the "Transactions." It is made by coating gutta-percha membrane with gelatine, thus rendering the one surface adhesive, while the other is quite impervious to moisture.

to lie against the margin of the upper cavity. This must be carefully introduced, and succeeded by three or four stars or balls of foil sufficiently large to fill the temporary cavity, and then thoroughly condensed by the plugging instrument. The forms shown in the accompanying figures will be found suitable for the purpose.

Fig. 147. [1]

Figs. 148, 149.



If this, the first part of the operation, has been successfully performed, the gold will be firmly fixed in the upper part of the cavity, and the most difficult part of the operation accomplished. We have now to fill what may be regarded as the secondary cavity. This may be done by adding successive

[1] Figs. 147-8-9, show instruments having the same general character, the first being adapted for introducing the gold, whether foil or sponge; the second and third for the condensation of the plug.

stars of adhesive gold, taking care that each is thoroughly adherent to, and condensed upon, its predecessor, and that each is laid on with some degree of evenness. If the latter caution is neglected, on completing the operation it will be found that the plug is perfectly solid in the centre and porous at the sides—a faulty condition which it is difficult to remedy without commencing the operation anew. In order to guard against the occurrence of this error, it will be well to test the plug from time to time with a square-pointed or a wedge-shaped perforating instrument. It may be necessary, when the lower wall is approached, to change the instrument in favour of one the blade of which is more bent upon the shaft (Fig. 149), in order to ensure the gold being carried to the bottom of the cavity. It has been assumed that the first portion of the plug was formed of foil moderately adhesive only, and that in the subsequent steps of the operation gold possessing the highest degree of adhesiveness was used. As good and perhaps a better result would have been obtained had the crystal gold been used, providing the cavity had been first lined with a thin layer of foil. There are those who in all cases employ the non-adhesive foil used upon the wedging system, and I have seen plugs so made that cannot be objected to; but I much prefer the use of a material which when consolidated forms one solid mass.

Fig. 150. (1)

(1) **Shows an instrument with an expanded extremity cut into minute cones.**

When no further addition of foil or crystal gold can be added, an instrument having a broad convex surface cut up into conical points (Fig. 152) will be found useful. It should be pressed firmly on the surface of the plug with a rolling motion. The gold will thus be reduced to a comparatively level surface. The presence of the wedge will protect the gum from injury during the process of filing to a level surface the plug and the surrounding tooth substance; the wedge should therefore be retained in its position until that part of the operation is completed. It is necessary that a free interval should be left between the teeth, in order that food and other matter should be readily removed. If an error is committed, it will be in the too sparing rather than in the too free use of the file. It only remains to complete the plug by polishing in the usual manner.

If the cavity be situated on the distal instead of the mesial surface of the tooth, or upon either of those surfaces in the bicuspids of the left side of the mouth, the steps of the operation will be the same as in the case already described, excepting as regards the position of the patient's head. The face must be turned a little towards or from the operator, as may suit his convenience.

Treatment of Simple Cavities in the Upper Molar Teeth.—It will not be necessary to enter minutely into all the details connected with plugging the molar teeth, as the account would be but a repetition of that which has already been described in connexion with the operation upon the more anterior teeth. The differences only need be pointed out.

The head of the patient should be well thrown back, and placed at a height to suit the convenience of the operator.

If the disease be situated upon the mesial surface, the tooth should be freely cut away, in the manner recommended in the treatment of bicuspids when decayed in the corresponding situation. The impervious plaster will render great assistance in preventing the tongue from bringing moisture to the tooth, and also in rendering it unnecessary to change the folds of the napkin, in case they should become saturated during the operation.

Fig. 151. (1)

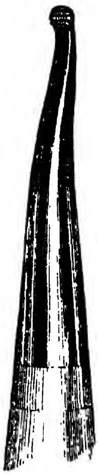
In introducing a plug upon the masticating surface, the accompanying form of instrument will be found serviceable (Fig. 151), more especially if the cavity be situated in the second or third molar.

When the distal surface is attacked by decay, the enamel-cutter must be freely used, and the tooth cut away until, on the commissure of the lips being drawn back by the first and second finger of the left hand, the cavity can be seen. The operation of plugging is far too difficult to admit of being successfully performed in a cavity which is out of sight. It will consequently be sometimes found necessary to reduce the tooth to a greater extent than would have been needed, had the disease been situated on the mesial surface of the tooth. In the introduction of the gold the instrument will enter the cavity at the angle formed by the distal and labial surface of the tooth, when situated on the right side of the mouth; and

(1) Showing an instrument for introducing adhesive foil or sponge gold into cavities in the masticating surface of the upper molars.

in order to afford the requisite space, this angle of the tooth must be reduced to a greater extent than that situated near the lingual surface. But if the operation be on the left molar, it will be found advantageous to submit the latter angle to a considerable amount of reduction. In either case, however, we must to a considerable extent be governed by the course taken by the disease, and the extent of injury it has produced.

Fig. 152. (1)



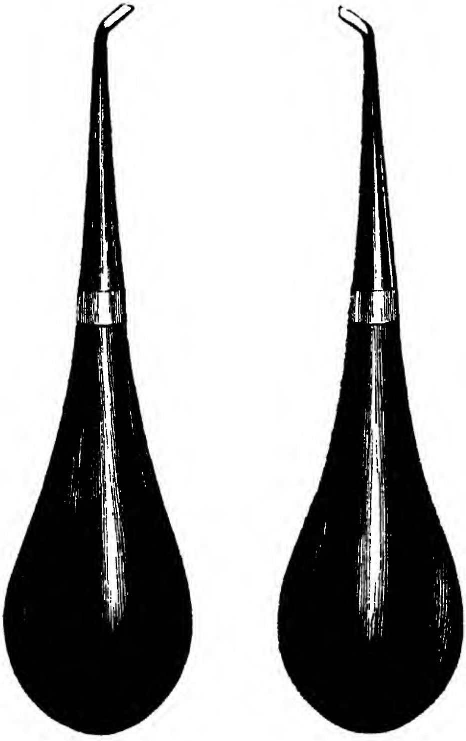
The preparation of the cavity must be proceeded with upon the same general plan as that already described, and the instruments used in plugging the bicuspid will be equally suitable for the molar teeth. In consolidating the surface of the plug, the accompanying form will be found suitable.

For cavities situated on the labial surface of the upper molars, a pair of instruments, right and left, somewhat of the forms given in the figure (Fig. 153), will be found serviceable. With the head thrown back, and the face turned to the right or left to suit the case, and the commissure of the lips drawn back, the cavity can be readily reached with the instrument, and a twist given to the blade will enable the operator to force the foil upwards and backwards, without allowing the shaft of the instrument to interfere with the teeth and lips of either jaw.

(1) Showing an instrument suitable for the introduction of crystal gold, or for finally condensing the surface of a foil-filling situated in the distal surface of an upper molar or bicuspid tooth.

No one will be found to question the superiority of gold over other fillings, but there are cases in which the crown is so

Fig. 153. (1)

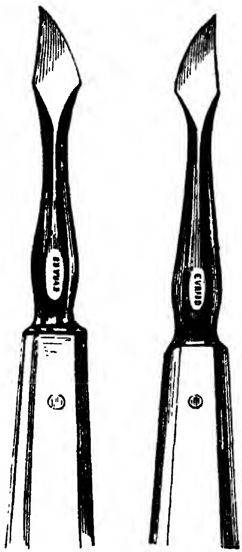


hollowed out that the tooth is reduced to a mere shell, quite incapable of withstanding the force necessarily employed in the introduction of foil or sponge gold. In the treatment of a case of this kind we shall do well to use amalgam.

(1) Right and left instruments for introducing foil into cavities situated upon the labial surfaces of the upper molar teeth.

The tooth may not last for any great length of time, but should it be rendered serviceable but for a twelvemonth, the interest of the patient will be better served than if the tooth had been broken down in an abortive attempt to make a gold plug.

Fig. 154. (1)



Again, there are those who will not submit to the prolonged operation entailed by using gold. They become so restless that the formation of a sound plug is rendered almost impossible; and seeing that a good amalgam is more likely to save the tooth than a defective gold plug, it will be wiser to use the former material. The slight discoloration which may ensue is in the molar teeth of minor importance. Gutta percha might be used, but it does not render the support to the fragile tooth that is afforded by the hardened amalgam, the surface of which will endure for years uninjured by mastication.

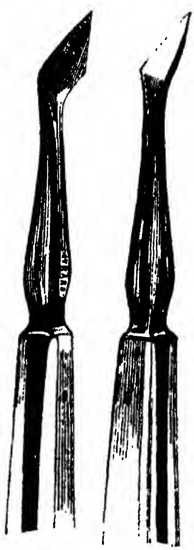
Treatment of simple cavities in the teeth of the lower jaw.—In operating upon the lower teeth the proceeding will be varied as respects the position of the patient, the form of the instruments used, and the precautions necessary to exclude the intrusion of the saliva from the part under treatment.

The enamel-cutter will be called into requisition, but the

(1) Right and left sabre-bladed enamel cutters, suitable for operating upon the mesial or distal surface of the bicuspids, or first molars of the lower jaw.

straight chisel-shaped instrument so useful in the upper, fails to meet the requirements of the operation in the treatment of teeth of the lower jaw. The subjoined forms will be found better suited for the purpose. For removing the mesial or distal surface of the canines, bicuspids, or first molars, instruments, the blades of which are sabre-shaped, and in a straight line with the shaft, will be sufficiently suitable, but the corresponding surfaces of the second and third molar teeth cannot be conveniently reached by straight instruments. For the latter teeth the blade should be placed at an angle of forty-five degrees with the shaft, and the cutting edge formed by a champfer from the under in one, and from the upper surface of the blade in a second instrument.

Figs. 155, 156. [1]



In the preparation of cavities in the lower teeth the same general rules given in respect to the subject generally, must be observed. It matters not where the cavity is situated, the plug will soon fall out unless the form is suitable.

Prior to the introduction of the gold in cavities situated in the mesian or distal surface of the lower incisor or canine teeth, the wedge should be inserted, and ample precautions should be taken for the exclusion of the saliva. After placing the head so that the face is turned sufficiently upwards to allow the saliva to flow towards the throat, a strip of the

[1] Enamel-cutters, with the blade placed at an angle with the shaft; the one being brought to an edge by a champfer from the upper, the other from the under surface of the blade.

impervious plaster should be placed upon the lingual surface of the gums and teeth, and between it and the tongue a tolerably thick fold or rope of linen. A corresponding fold may then be placed between the lip and gums, the two being retained in position by the thumb and forefinger of the left hand brought round the head of the patient.

The cavity having been rendered perfectly dry, the gold may be introduced with instruments similar to those used in conducting the like operations on the corresponding upper teeth. Cavities in the canines may perhaps in some cases prove exceptional, and require similar management to that which will be subsequently described as applicable to the treatment of the contiguous bicuspids.

Fig. 157. (1)

In filling cavities situated on the mesian or distal surface of the last-named teeth, the spiral-bladed instrument may be employed with advantage, the gold being introduced from the labial side of the tooth. When the distal surface of the right teeth is under treatment, the operator should stand to the right, and a little behind his patient; and on the side, but slightly in front, when the corresponding part of the left bicuspids is operated upon,—the patient in the former case leaning his face to the left, in the latter towards the right side. Those instances in which the crowns of the teeth are reduced to a considerable extent on the lingual side, in con-

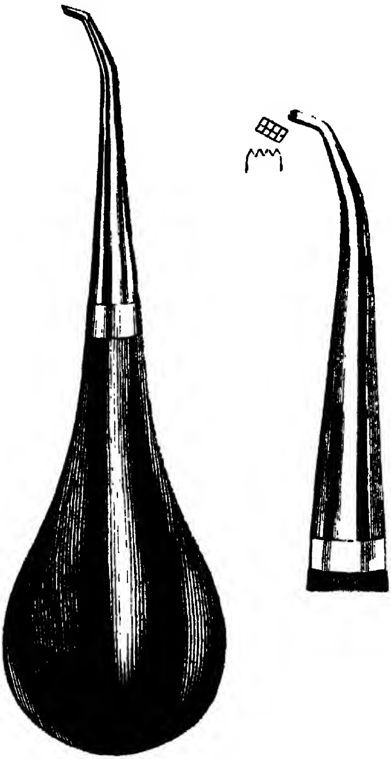
(1) An instrument used for condensing the surface of the gold inserted either on the distal side of the right, or the mesial side of the left bicuspid. An instrument resembling the one shown in the figure is well adapted for condensing the surface of the gold.

sequence of the disease having encroached upon the masticating surface as well as upon the neck, will allow the foil or sponge to be introduced from above more advantageously than from the side. The plugging instrument should have a short blade, bent nearly at a right angle, and the shaft itself should also be slightly bent in the same direction, at a distance of about three-eighths of an inch from the blade. The two curves will enable the blade to hook over the crown of the tooth and enter the cavity. The gold having been introduced, the subsequent stages of the operation involve only the proceedings usually adopted in completing a plug.

In operating upon the molar teeth it is that we encounter the greatest amount of difficulty, owing to the large quantity of saliva which collects and overflows the teeth. Some patients can swallow while the mouth is open, and thus from time to time get rid of the accumulated fluid, but others cannot; and if means for its removal are not adopted, the crowns of the teeth become entirely submerged. To overcome this difficulty, folds of linen must be placed in the mouth, and renewed so soon as they become saturated. The patient's head should be thrown slightly back, and turned a little towards the side opposite to that on which the faulty teeth are situated, in order that the saliva, when the amount is not excessive, may flow from the teeth under operation. The cavity having been fully prepared for the reception of the plug, a strip of the impervious membrane should be placed upon the lingual surface of the molar teeth and subjacent gums; a small patch may also be placed upon the salivary duct, which opens upon the surface of the cheek near the first molar of the upper jaw. After

rolling a napkin into a rope, bend it in the form of a loop, and lay the curved portion over the masticating surface of the molar posterior to the cavity about to be filled; then bring the two ends outwards, allowing the intermediate portions to lie by the sides of the teeth, one on the lingual side, the other on the labial side of the teeth. If the operation is on the right side of the mouth, the twisted napkin can be retained in position by the thumb and second finger of the left hand brought round from the back of the head. The thumb, by pressing the linen upon the impervious membrane, will cause it to adhere firmly to the teeth, and thus effectually keep out the saliva from that side of the teeth; and if a fold of linen be placed between the cheek and the upper teeth, the patch of membrane will be held against the orifice of the pa-

Figs. 158, 159. (1)



(1) Instruments constructed with a double curve for filling cavities in the masticating surface of the lower molar teeth; the former being suited for ordinary foil, the latter for adhesive foil or sponge gold.

rotid duct, and temporarily close it. With a little management, we shall succeed in keeping the tooth under operation dry for a sufficient length of time to enable the gold to be introduced. When the operation is on the left side of the patient's mouth, the arrangement will differ only in the position of the left hand, which will then be in front; the thumb will rest on the labial, and the second finger on the lingual, side of the teeth. By using the second finger for the retention of the napkin, the first is left free for assisting in the guidance of the instrument, or the adjustment of the napkin should it become displaced. If the flow of saliva be excessive, a small fold of linen may be placed behind the incisor teeth, and when saturated, renewed with the right hand, while the left keeps the napkin which surrounds the faulty tooth undisturbed. If the cavity under treatment be situated upon the masticating surface, an instrument presenting a double curve will be found to meet the requirements of the case. (Fig. 158.) The curve of the shaft carries the instrument over the contiguous teeth without the handle being inconveniently raised. After the gold is introduced, another form of instrument will be found useful for condensing the plug (Fig. 160), which, being exposed to wear, cannot be too hard.

Fig. 160. (1)

(1) An instrument for compressing plugs introduced in the masticating surface of the inferior molars. The handle is grasped with the blade passing downwards from the lower border of the closed hand.

The shaft is bent almost in the shape of the letter S, and when used descends from the lower border of the closed hand, the blade terminating in the working surface being in a

Figs. 161, 162. (1)

vertical position. It is necessary to support the jaw of the patient with the left hand.

(1) A right and left double-curved instrument, for introducing foil into cavities on the labial surfaces of the lower molars.

For operating on cavities in the labial surface, a double curved instrument, similar as respects the blade, but with the curve in the shaft in a different direction to those last described, will be found very serviceable. When in use, the shaft will be nearly parallel to and a little above the crowns of the lower teeth, the blade descending, and the working extremity directed obliquely downwards and backwards (Figs. 161, 162.) By adopting this form, the operator is enabled to keep in view the lower margin of the cavity during the packing of the foil—the part in which the plug is most frequently defective, and consequently requiring the greatest care in its construction.

The most troublesome cases to treat with success are those in which the disease is situated on the distal surface of the lower molars, more especially when the cavity is small, and confined to the neck of the tooth. The free use of the enamel-cutter is required, and it is often with great difficulty that the crown of the tooth is sufficiently cut away to enable the cavity to be reached. A good quality of steel, well tempered, is required to enable the operator to cut through the sound enamel of molar teeth, more especially when, as in lower molars, the position is unfavourable.

In describing the treatment of caries, the observations have been confined to those cases in which the pulp of the tooth has not been involved in the disease—cases in which the cavity to be treated has been simple. The more complicated forms of the disease remain for consideration. They will come under two divisions; first, those cases in which the pulp is exposed, but not obviously diseased; secondly, those in which the pulp cavity is laid open, and the pulp diseased or dead.

Caries with perforation of the pulp-cavity, the pulp being

healthy, is a condition that is but seldom seen, excepting as the result of an operation. The dentine in contact with the pulp having been softened by disease, is removed when the cavity is prepared for filling, and the pulp thereby exposed. Perhaps it would be wrong to assume that in such a case the pulp is absolutely sound, but there may be nothing to show that it is diseased, and nothing to warrant the adoption of any other treatment than that which would be pursued if its healthiness were unquestioned.

I am not prepared to say that we never find the pulp of a carious tooth the cavity of which has been laid open by the disintegration of its walls, free from disease; but cases exhibiting such conditions are very rare: whereas the exposure consequent upon the removal of carious dentine is not very uncommon. It is an unfortunate accident which cannot always be avoided—unfortunate, because it would have been better to have retained the softened tissue, the removal of which occasioned the exposure of the pulp, and to have protected it from further decomposition by plugging the cavity. Had this treatment been adopted, we should, on examination, after the lapse of a few months, have found that the pulp itself had become calcified at the point corresponding to the disorganized dentine. The presence of a plug stays the further progress of the disease, and prevents the fluid of the mouth from penetrating through the defective wall of the pulp-cavity, while the softened tissue retained as a covering to the pulp saves the latter from the effects of sudden changes of temperature which would have been directly conveyed through a metal plug but for the intervention of the dentine. When, however, the exposure is produced,

during an operation the pulp is usually wounded, and bleeds freely. The pain is commonly acute, but soon subsides. After the bleeding has ceased the cavity should be syringed out with tepid water, and carefully dried with cotton wool. The actual state of the walls of the cavity, the size of the perforation into the pulp-cavity, and the condition of the dentine immediately around the hole, can then be examined. If it be found that the whole of the softened dentine had been removed, that the aperture into the pulp-cavity is very minute and surrounded by sound tissue, we may proceed to plug the tooth in the usual manner, adopting the precaution of laying a small piece of foil, folded six or eight times upon itself, over the aperture. But should it appear that the opening into the cavity is of considerable size, or that, though small, it is surrounded by softened tissue, the removal of which would increase its size, a different mode of proceeding must be adopted.

As much as possible of the disorganized tissue, short of enlarging the aperture, should be carefully cut away, taking care that the walls of the cavity are reduced to a suitable form; an artificial substitute for the missing portion of the wall must be provided, in the preparation of which two conditions should be observed. Like the dentine, it should be a non-conductor, and also, like it, be capable of protecting the pulp from pressure. To possess the latter quality the material must have a certain degree of strength, and be slightly concave on that surface which is presented towards the pulp.

It is usual to speak of the operation under the title of "capping" the nerve or pulp, and the substance shaped to

cover the pulp as the cap. Gold, ivory, the quillhorn, and many other substances have been used.

A piece of suitable size cut from the barrel of a stout quill is readily produced, and is perhaps as good as anything we can find. In determining the shape and size of the cap, it must be remembered that there is no objection to the whole of the floor of the cavity being covered; at all events, the cap should be sufficiently large to ensure its edges resting at some little distance from the margin of the aperture by which the pulp is exposed, otherwise it will fail to protect the latter part from pressure during the operation of plugging, and subsequently from that consequent upon the tooth being used in mastication.

While it is necessary that the exposed portion of the pulp should be perfectly protected from pressure, it is perhaps equally desirable that a space should not be left in the concavity of the cap into which the pulp could be received, were it from any cause to protrude through the aperture in its proper cavity. The natural conditions of the part involved should be observed, and as far as possible restored. To follow out these indications, the exposed pulp should be protected by an artificial covering, which, while it protects, will at the same time keep the pulp within its natural limits, and defend it from sudden changes of temperature.

In adjusting the cap, some little time and attention must be given, in order to secure its taking a level bearing upon a surface which may be, and frequently is, uneven; and it should also, if practicable, fit to the walls of the cavity with sufficient tightness to secure the retention of its position during the introduction of the gold or other material.

Before, however, we proceed to fill the cavity, it must be determined whether the plug is to be regarded as a temporary or a permanent one. Should the treatment prove successful, the exposed portion of the pulp will, in the course of a few months, become calcified, and the aperture in the cavity stopped from within by a layer of secondary dentine. Assuming this process to have been effected by nature in a tooth that has been permanently plugged over a cap, it is quite possible that the filling will preserve the tooth for an unlimited period, but it is far more probable that a plug introduced under such circumstances will, after a time, fail, and the failure perhaps may not be discovered until the crown of the tooth is all but lost. Had the filling been regarded as temporary, the tooth would have been examined after the lapse of six or eight months, the temporary plug removed, and a gold filling introduced under circumstances far more favourable than obtained when the operation was complicated by the presence of a cap and general tenderness in the tooth.

As a general rule, I believe it is wise to employ a temporary plug over a cap. Mr. Thomas Rogers, in an elaborate paper "On Capping the Exposed Pulp," published in the "Transactions of the Odontological Society," vol. i. (and to which I must refer the reader for a full account of all that relates to this subject), makes the following statement:— "As I consider it to be a matter of great importance to avoid as much as possible all irritation to the tooth in this delicate condition, I fill over the cap with amalgam."

I believe the gutta-percha filling would answer quite as well as amalgam, but whichever of these materials we select, its removal, and the substitution of a gold plug, should

be insisted on so soon as the tooth is in a proper condition to warrant the permanent operation.

It has been assumed that in all cases of exposure of the pulp during an operation, or under circumstances that justify the opinion that it is free from disease, our treatment should be addressed to its preservation.

Such is the general rule. But there are cases in which this rule cannot be acted upon, on account of the impossibility of following out the treatment required for its observance.

The walls of the cavity may be so shallow that the retention of a cap with a plug external to it becomes a matter, not only of difficulty, but of impossibility. Again, the crown of the tooth may be so much injured that, even if the pulp were capped, the introduction of a plug would be attended with risk of breaking down the shell. The patient may be unable to return to you, or to obtain the assistance of a dentist for some years to come. On the occurrence of circumstances such as those enumerated, the protective system of treatment must be abandoned. Instead of striving to save the pulp, means must be adopted to bring about its destruction. The most effectual, and at the same time safest, manner of accomplishing this end, consists in passing a very fine and flexible broach through the opening in the pulp-cavity up the fang of the tooth. When the further progress of the instrument is arrested by the diminished size of the cavity, a rotatory motion should be given to the broach. The effect will be to cut off the pulp in the root of the tooth at the most constricted part of the canal, and, consequently, of the pulp itself. This treatment is applicable to single-rooted teeth only, and even in these the operation is sometimes attended with great pain,

owing to the difficulty of passing the broach to its proper destination.

By destroying the pulp, we convert the once simple into a compound cavity, the one part being formed by the pulp-cavity, the other by the cavity produced by the primary disease.

The two cavities have now to be regarded as one, and steps must be taken to reduce it to a suitable form for the reception of a plug. The canal in the root, after the withdrawal of the pulp by a spirally twisted broach,(1) should be enlarged with a drill, and the distinction between the two cavities destroyed by graduating the walls of the outer into those of the inner cavity.

There appears to be some difference of opinion as to the time at which a tooth can be most safely plugged after the pulp has been removed. There are those who consider that the cavity should be filled with cotton wool and mastic, and the tooth allowed to remain unmolested until any irritation that may supervene upon the destruction of the pulp has completely subsided.

The experience derived from my own practice has led me to arrive at a different conclusion. In the cases which have proved most successful, the canal in the root has been filled immediately on the cessation of the hæmorrhage, and the

(1) Broaches for destroying and withdrawing the pulp should be very fine, elastic, and flexible, otherwise the capability of following the curved course necessary for the effective performance of the operation will not be obtained. Fine watchmaker's broaches, reduced to a soft spring temper, are commonly used; but a more effective instrument may be made by taking a firm watch-spring, and grinding it down until a square-sided broach is produced. If in a second the temper is slightly lowered, the point may be twisted to the extent of three or four turns.

operation completed on the same or a following day. When this course has been followed, irritation of the alveolar membrane of the socket has seldom arisen; but when from any cause the permanent filling of the root has been postponed for some days, a certain amount of irritation has come on, the tooth becoming slightly raised in the socket, and painful when pressed upon. In some instances, the unfavourable symptoms have gradually passed away; in others, the tooth has been lost.

The different results consequent upon the two modes of treatment may be explained upon the assumption that when the permanent filling is used, the ingress of oral fluids is perfectly obstructed, and the accumulation of anything more than a very minute amount of coagulum prevented; whereas, when cotton wool only is employed, the permeation of saliva is not rendered impossible, neither is the collection of a relatively larger amount of coagulum guarded against.

The consequences which follow the laceration of a soft tissue will, *cæteris paribus*, generally be proportioned to the amount of surface injured. In the case of a tooth, the sectional area of the pulp near the end of the root is so small, that its division in a healthy subject will not be followed by inflammation, unless the injured part is subsequently exposed to irritation. But should the saliva find access, or a large coagulum collect in the vacant cavity or in the interstices of the wool, and decompose, the lacerated surface will become inflamed, and the disease will extend from the remnant of pulp to the periosteum of the root and socket.

There are other methods than that just described of de-

stroying the pulp; and in cases where the use of the broach is attended with difficulty, owing to the position of the opening in the pulp-cavity, or to the tooth having more than one root, they are to be preferred. The use of escharotics for destroying the pulp can no longer be looked upon as a novel mode of treatment. The practice has stood the test of time, and may be regarded as one of many great improvements in dental surgery matured during the present generation. Ruspini, in a pamphlet published in 1797,(1) mentions destroying the pulp, and subsequently filling the cavity, but the operation was not generally adopted, and its details and results worked out, until within the last twenty years. It is singular that a principle the soundness of which had been fully established for the best part of a century in the operation of pivoting, should not have been applied to the preservation of teeth the crowns of which were but partially decayed. Every one knew that after the removal of the pulp, a piece of gold wire might be passed up the healthy root of a front tooth, for the purpose of supporting a new crown,

(1) Ruspini, in his "Treatise on the Teeth," the eighth edition, published 1797, makes the following statement: "Whenever caries appears it must be opened with a masterly hand to the very bottom. If in doing so the chord of the tooth is discovered, the operation will prove painful; but still it must be destroyed, either with an instrument, or with the actual cautery, or some caustic liquor.

"We ought to be very attentive in the operation; for if we do not utterly destroy the said chord, but only prick it, the most raging pains will succeed, together with an inflammation, and the inevitable necessity of drawing the tooth.

"When a tooth by the loss of its chord is become insensible, it must be filled with lead or gold, in order to prevent any acid or saline particles from getting through the hole where the chord went into the socket, to hurt its delicate membrane; for then there would be no means of redress but by drawing the tooth; hence all the care that had been taken, and all the pain that had been endured to render the tooth insensible, would then be of no avail."

but it did not occur to those who practised pivoting that the crown of a tooth could be preserved by an operation conducted upon the same principle. It is not, however, very difficult to see how the fact was overlooked. The gold pin was not introduced for the purpose of preserving any portion of the faulty tooth, but was regarded as purely subservient to the support of a new crown, in the place of that which had been too far injured to render its retention desirable.

There are several general rules which may be laid down in respect to the selection and the application of escharotics. The first in point of importance is, that they should not be employed when there is reason to suppose that the peridental membrane is diseased, and for the following reason. It seldom happens that inflammation external to the root arises, excepting as an extension of disease originating in the pulp, during the progress of which both the pulp itself and the canal in the fang become considerably enlarged. Consequently the action of the caustic may not be limited to the pulp, or if it be, that portion which is allowed to remain will be in a diseased condition, and capable of keeping up the morbid action in the alveolus.

The second rule to be observed is, that no more of the escharotic should be applied than will be sufficient to produce the required effect. For if an excess be used, it is more than probable that the action will extend beyond the required limits, and produce inflammation of the peridental membrane. The third rule is, that the application should not be continued over a longer period than is necessary to ensure the destruction of the body of the pulp. If allowed to remain for a long time in the tooth it may permeate the dentine and affect the peridental membrane; whereas, if the body of the pulp be dead,

the degree of sensibility of that which remains in the roots is so much lowered that it may be withdrawn without occasioning any considerable amount of pain. By observing this precaution we ensure the removal of the caustic, and leave the pulp at the point of rupture in a much more favourable condition for healing than if it had been saturated by the escharotic.

The fourth rule is, that escharotics should not be applied to a tooth with the view of destroying the pulp, unless the fang is fully developed, and the aperture through the the extremity of the root reduced to its ultimate size. In young subjects the canal in the root of a tooth is very large generally, but more especially at the terminal portion, and the pulp maintains a corresponding size.

The expediency of destroying the pulp by means of an escharotic having been determined on, the substance best fitted to produce the effect must be selected. The mineral acids, nitrate of silver, chloride of zinc, and many other substances possessing caustic properties, have each in turn been used. Arsenious acid has, without giving rise to a greater amount of pain, been found to act with more certainty, and in less time, than any other agent. The certainty of its operation is so great a recommendation that arsenic is almost invariably employed in preference to any other description of caustic. The extremely active character of this substance as a poison led me some years since to prefer chloride of zinc, which, although less certain, is a less dangerous agent to employ in the mouth. At that time the minimum amount of arsenic capable of producing the required effect had not been determined, and several cases had come under my notice in which slough-

ing of the gum and the loss of the tooth followed its use. More extended experience has cleared away many doubts as to the advantages offered by this mineral, which has now taken its place among the most useful of the agents at the disposal of the practitioner.

The twenty-fifth of a grain of arsenious acid, reduced to a fine state of division (a dose which, if swallowed, would be productive of no injury), is sufficient, when properly applied, to destroy the vitality of the pulp of a large molar tooth. Some practitioners prepare a compound, made by grinding together equal parts of arsenic and morphia, the narcotic being added for the purpose of mitigating the pain produced by the corrosive action of the mineral substance. In my own practice, I prefer to use the arsenic alone, and applied in the following manner: a small ball of cotton wool, scarcely larger than a pin's head, is formed on the end of a fine broach, and dipped into creosote. The arsenic is then taken up on the saturated wool, which, thus loaded, is carefully placed in contact with the exposed portion of the pulp, and retained in position by the introduction of a second piece of wool, saturated with a solution of mastic.

When the cavity is situated in the masticating surface of a tooth, the application is readily effected, but if it be upon the median or distal surface, a little more caution is required, otherwise the arsenic may find its way to the gum, and produce, if not permanent mischief, a considerable amount of temporary discomfort.

The introduction of the second piece of cotton will, if the movement be not guarded against, force towards the gum that which is charged with the escharotic. In order to pre-

vent such shifting of position, a small piece of wool should be laid between the teeth, close upon the edge of the gum. The charged cotton may then be placed in position, and the wool provided for its retention introduced. The patient must be directed to avoid masticating upon the tooth, or disturbing the application by any other means, even though the pain it occasions should be severe. Both the intensity and the duration of the pain produced by the destructive action of arsenic upon the dental pulp, are inconstant to a degree for which the recognisable differences in the cases fail to account. One patient will tell you that the application produced no pain, another that the toothache was most severe, and lasted for ten or twelve hours, while a third will describe the pain as moderate in degree, and of a very bearable kind.

After the lapse of from twelve to thirty-six hours, depending on the size of the tooth and the extent of surface exposed to the action of the escharotic, the whole of the cotton wool may be removed, and the effects of the application ascertained. If the result has been favourable, the sensitiveness, before so great, will have entirely passed away. On passing an instrument into the pulp-cavity slight bleeding may follow, but the patient will not complain of pain. Should the pulp, however, on examination, be found in an acutely sensitive condition, it may be concluded that the ingress of the arsenic has been prevented, either by the aperture into the pulp-cavity being extremely small, or by a mass of secondary dentine lying against the opening. But whatever cause may have retarded the operation of the escharotic, the application must be renewed, and a further time given. The required effect

having been produced, the whole of the decayed dentine should now be removed, and the opening into the pulp-cavity sufficiently enlarged to allow the pulp to be withdrawn entire. This part of the operation may generally be effected by a fine broach, hooked at the end, or by a twisted flat broach of the kind already described. The operator must be prepared to meet with occasional difficulties, owing to the presence of masses of secondary dentine within the substance of the pulp. They are sometimes so large and irregular in shape, perhaps dipping down into the fangs, that their withdrawal occupies some little time, the pulp becoming broken down by the operation. In such cases the contents of each fang must be drawn out separately. Although the body of the pulp has become insensible, more or less pain will be felt when the pulp situated in the roots of the tooth is broken across at or near the orifice by which it passes into the alveolus, but the pain subsides immediately. Should slight hæmorrhage follow, the operation may be suspended for a few minutes, by which time the bleeding will have ceased.

If the treatment has been successful, the pulp cavity of the body and of the roots of the tooth will have been cleared of their natural contents. The further treatment will consist in filling the roots, when practicable, with gold, then the pulp-cavity, and lastly the external cavity. The necessity of filling the roots has been strongly insisted on by the American writers, and there can be no doubt of the advantage which results, supposing the canals to have attained a certain magnitude. But when the root is small and its cavity too minute to admit a fine broach, it may be left without the fear that any evil consequence will ensue. In a first permanent

molar of the upper jaw, for example, the anterior and palatal roots should be filled, but the posterior root is commonly traversed by a canal too small to render filling necessary.

Some doubt has been expressed as to the practicability of filling the roots of teeth, and no doubt the operation is tedious; but when sufficient time is given very little difficulty is experienced. In front teeth it is simple enough, and in the back teeth it must be rendered simple, otherwise the result will be imperfect. The crown of the tooth must, in fact, be cut away until the pulp-cavity is fully exposed and its continuation in the roots brought within the reach of an instrument. It will in most cases be found desirable to enlarge the canal with a broach. The question constantly suggests itself as to what extent the enlargement shall be carried, and to what depth. The determination of these points will depend upon the peculiarities of the case under treatment. The object of the enlargement is to facilitate the operation of plugging. In some instances it may be dispensed with, in others it must be carried to a considerable extent. Thus, when the canal is large at one part of its circumference, and reduced to a mere slit at another, it will be advisable to reduce it to something approaching a regular outline. In respect to depth, the enlargement may be carried with advantage to the point beyond which a fine broach will not pass in the natural state of the root.

Having fully prepared the cavity, both in respect to its form and the removal of extraneous matter, and protected the tooth from the influx of saliva, the cavity must be made perfectly dry by passing into the roots cotton wool rolled upon a broach.

We may now proceed to pack in the gold by one or other of the following methods.

Roll round a broach which will readily pass to the bottom of the canal a small amount of foil, firmly, but not so tight but that the broach can readily be withdrawn. The gold may then, while upon the broach, be pressed to the bottom of the cavity; withdraw the broach a short distance, and again return it, using sufficient pressure to consolidate the gold, which will be carried down before the instrument. After thus forcing in the first tube of foil, the process must be repeated again and again until the root is filled.

In the place of the tube of foil, very narrow ribands may be used, but the operation is more tedious, and does not possess any advantage over the method already described.

A third method consists in taking three or four thicknesses of foil, and cutting therefrom very small square pieces, which are one by one introduced upon the point of the broach, and consolidated.

Some little attention must be given to the instruments employed for this delicate operation. If an ordinary four-sided broach is used, the temper must be reduced to that of a spring, otherwise it will snap off during the operation, a portion probably remaining in the cavity. I have known this accident happen in several cases, and a portion of steel has unavoidably been allowed to remain in the tooth, and without any evil consequence becoming immediately developed.

A preferable instrument may be made either from a piece of steel wire, or by grinding into a cylindrical shape a strip taken from a clock spring. The extremity, if left flat, will carry the gold to the bottom of the cavity more readily than

it would do were an edge or point produced. The curved course which the broach is required to take renders elasticity absolutely essential, and in no way can this be obtained more readily and more certainly than by adapting to our purpose a piece of watch or clock spring.

The root or roots being plugged, the subsequent part of the operation does not vary from that of making an ordinary plug, excepting that the cavity in the tooth is unusually large, and will therefore occupy a greater length of time than would be consumed in filling a simple cavity. If a large molar, either of the upper or lower jaw, be the subject of treatment, the compound cavity, even after the roots of the tooth are filled, may be so deep that difficulty will be encountered in packing non-adhesive gold so as to form a single plug. In such cases it is well to first fill perfectly the pulp cavity, and then to proceed to make the more external part of the plug.

When the foregoing operation is carefully performed, the result is generally very satisfactory. The tooth is reduced to the condition of one upon the root of which a new crown has been fixed by a pivot. In each the connexion with the living tissues is limited to the external surface of the root; and in one, as in the other, inflammation of the dental periosteum may ensue soon after the operation, either if care be not observed in its performance, if the periosteum be diseased, or if the patient be in a bad state of health when the operation is performed.

It must, however, be borne in mind that we have been treating of those cases only where the pulp has been exposed during an operation. The presence of disease in the dental

periosteum will therefore be rare, and the source of failure may consequently be looked for in the general state of health of the patient or in the manner in which the operation has been performed. I can call to mind several instances of failure in my own practice which were consequent upon a certain portion of the pulp having retained its vitality and held its place unobserved in the tooth. In one case an upper molar became very sensitive to changes of temperature, sensitive when pressed upon, and slightly loose. It was removed, and on examination the pulp in the posterior distal root was found to have retained its vitality and to have become inflamed. In one instance an upper bicuspid became very painful. After removal the pulp on the one side of the compressed cavity was found to have escaped the broach and retained its vitality. In each case the source of failure lay in the incomplete destruction and removal of the pulp.

In respect to the general health, some little caution should be observed in the selection of the cases for filling the roots and the pulp-cavity. It will be wise to avoid the operation in those who present the strumous diathesis, more especially where it is coupled with great sensibility of the teeth generally. Persons who are liable to neuralgic pains in the head and face are unpromising subjects, and we can scarcely expect a very favourable result where the gums are in an unhealthy condition.

The occurrence of a small and unimportant chronic gum-boil, coming and going with little or no inconvenience, must be placed amongst the results which may follow the destruction of the pulp and the subsequent filling of the pulp-cavity. In respect to the root itself, changes, I believe, commence from the time of the operation, and proceed more or

less slowly until the tooth is lost. In pivoted teeth the root sometimes becomes enlarged, but more commonly suffers a diminution of bulk. In a case which came under my notice, the pivot had been exposed by absorption on one side of the root; in another a sufficient amount to ensheath the gold pin only remained. Again, if we take the roots of teeth which, after the loss of the crown, have had the pulp-cavity sealed up by secondary dentine, we shall find that either additions of cementum have been made to the surface, or that the surface has been gradually wasted by absorption. In many cases there will be ample evidence to show that the two actions have alternated. Ultimately the waste exceeds the repair, the root is shortened, loses its implantation, the socket disappears, and the tooth, after the lapse perhaps of some years, falls out.

Other methods of treating an exposed pulp than those already described have been proposed, and for a time found favour. Mr. Hullihen described an operation which has since received his name. It consists in drilling a small hole through the neck of the tooth into the pulp-cavity. The perforation is made either under the free edge or through the gum, a short distance above its terminal margin. The cavity produced by caries is then filled permanently, leaving the artificial perforation open. But as this operation relates to the treatment of diseased pulp, its further consideration may be postponed.

Some few years since it was proposed to char the exposed surface of the pulp by electric cautery, with a view of destroying the exposed portion preparatory to the introduction of a plug. In my own practice the advantages derived

from this mode of treatment were very questionable, and the operation was therefore abandoned.

Recently, however, the subject has again attracted attention, and forms the matter of a paper published by Mr. Harding in the "Transactions of the College of Dentists." To this paper I shall have occasion to refer when the diseases of the dental pulp are considered.

Dental Exostosis.—The implanted portions of the teeth, like other parts of the skeleton, are liable to local hypertrophy. In the bones the structure is uniform throughout their substance, and the new tissue does not materially differ from that to which it is added. The roots of the teeth present this point of difference: they are composed of dentine clothed with an external layer of cementum, a tissue which offers no striking character by which it can be distinguished from ordinary bone. In exostosis this layer becomes thickened either locally or generally, the dentine in no case participating in the enlargement. The disease may be defined as an addition of tissue, normal in character, but abnormal in amount, to a pre-existing tissue of the same structural character. If, for example, we make a section from a tooth the root of which has been increased in size beyond the natural dimensions, an unnaturally thick layer of cementum will be found, but it will in many instances be difficult to point out a sharp line of demarcation dividing the pre-existing from the recently-added tissue.

Fig. 163. (1)

In respect to the structure of cementum, it scarcely falls within the scope of the present work to enter minutely into

(1) An upper bicuspid tooth, with exostosis of the cementum of the root.

its histological characters. For a full description of these the student is referred to Mr. Shelley's recent paper in the "Transactions of the Odontological Society,"(1) to works on Histology, and to the previous publication of the author. But a little space may be given to the consideration of the more prominent features of the tissue.

The structural characters depend in a great degree upon the amount of tissue present. When it is limited to a thin layer, the lacunæ are altogether absent, and even canaliculi do not appear until a certain thickness is attained. If a longitudinal section of a front tooth be taken for examination, the cementum near the neck will present a thin layer of transparent tissue, marked with faint indications of granularity, accompanied in some cases with an obscure linear appearance, suggestive of the idea that the calcification of parallel fibres contributed largely to its production. Proceeding in the direction of the root the cementum thickens, and is traversed here and there by canaliculi, and still further down lacunæ make their appearance, first as a single series, then, with an increased thickness of the cementum, in numbers; the number generally depending upon the thickness of the tissue. The canaliculi of neighbouring lacunæ anastomose freely with each other, and establish a network of communication throughout the whole body of the cementum, and occasionally become connected with the terminal branches of the dentinal tubuli. The communication thus established between the two tissues has been doubted. Several prepara-

(1) "On Dental Exostosis." By Herbert Shelley, Esq., M.B. Lond., M.R.C.S.; and "Transactions of the Odontological Society of London," 1856-57.

tions, however, in my own possession, demonstrate the fact beyond cavil.

The occurrence of vascular canals (Haversian canals) is to a certain extent exceptional, being dependent upon the presence of a larger amount of cementum than is usually found in perfectly healthy teeth. Their presence is not, however, necessarily an indication of disease; for when two contiguous roots are united by the intervention of cementum, a vascular canal will not uncommonly be found to traverse the medium of union. In bone, the vascular canals are distinguished by one or other of the following characters. They are either surrounded by concentric laminæ of osseous tissue, or they are enclosed in tissue which has not a well-pronounced concentric arrangement of the laminæ. In the former case the lacunæ partake in the concentric disposition, and direct a large portion of their canaliculi towards the Haversian canal: in the latter their arrangement is less definite, and the canaliculi are directed with less regard to the position of the contiguous vascular canal. In the one instance the characters indicate the presence of secondary bone, or bone which has been developed to supply the place of pre-existing bone removed by absorption; in the other, the presence of primary bone, or that which has been developed in temporary cartilage, or upon the surface of an existing bone. It being to bone developed under the latter circumstances that cementum is most closely allied, the process of its formation may be considered with advantage. In young subjects the shafts of long bones are gradually increased in diameter by additions to the surface. The flat and other bones are increased in thickness by a similar process, and with the femur or humerus, will be

found equally convenient for examination and description. If we take either of the latter in a perfectly fresh state, and make transverse sections, either by cutting small fragments with a sharp knife, or even by grinding, taking care to preserve as much of the periosteum as possible, the following appearance will, by means of the microscope, be recognised. Starting up from the general surface of the bone will be seen a series of processes, disposed at more or less regular intervals, producing ridges and furrows, which, for the most part, follow in the length of the bone. Each process is terminated either by a rounded or a dilated extremity. By the increase of the dilatations of contiguous processes, and their ultimate contact and union, the grooves are converted into canals, which are occupied by bloodvessels. The new bone has, in fact, been moulded around the vessels of the periosteum—a process by the repetition of which the shaft of the bone may be thickened to an indefinite extent. In bone produced under the foregoing circumstances, the indications of lamination are generally indistinct, and when present, follow the general surface of the bone. The arrangement of the lacunæ is subservient to that of the laminæ, consequently in the primary bone the absence of the concentric order in the latter is accompanied by a similar deviation on the part of the lacunæ and canaliculi.

It is to this description of primary bone that the cementum of the teeth is most closely allied, and from which it is difficult to point out any distinguishing structural character. This close resemblance in the two tissues, when developed, renders it desirable that some account should be given of the manner in which the former is developed.

"If the advancing edge of a parietal bone be taken either from a human fœtus or a fœtal lamb, and the pericranium and dura mater be carefully removed from their respective surfaces, we shall find the growing bone still invested with soft tissue both on the outer and inner surface, which is prolonged from the free edge. When examined under a favourable light this tissue will show differences of character in different parts, varying with the distance from the bone at which the observations are made. Thus, if attention be directed to the part furthest removed from the bone, it will be seen that the membrane-like mass is composed of oval cells with slight prolongations from the extremities, which are frequently arranged in the form of bands of fibrous tissue. Dr. Sharpey has observed that the membrane into which the bone extends is like fibrous tissue in an early stage of development, and this observation is strictly true when confined to the part indicated, but the analogy ceases as we extend our examination towards the bone. Here in the place of cells with elongated processes, or cells arranged in fibre-like lines, we find cells aggregated into a mass, and so closely packed as to leave little room for intermediate tissue. The cells appear to have increased in size at the cost of the processes which existed at an earlier stage of development, and formed a bond of union between them. Everywhere about growing bone a careful examination will reveal cells attached to its surface, while the surface of the bone itself will present a series of similar bodies ossified. To these we propose to give the name of *osteal cells,* as distinguished from lacunal and other cells.

"In microscopic characters the osteal cells closely resemble

the granular cells of temporary cartilage, so closely indeed, that the latter when detached from the cartilage could not well be distinguished from them. They are for the most part spherical or oval in form, and lie on the surface of the growing bone in a crowded mass, held together by an intervening and apparently structureless matrix. Here and there we find a cell which has accumulated about itself an outer investment of transparent tissue, and has in fact become developed into a lacunal cell destined to become a lacuna. (1)

(1) The various views which have been entertained regarding the formation of the lacunæ and canaliculi have been concisely stated by Dr. Sharpey, *op. cit.* p. 158. He observes, that "they are generally supposed to be derived from the cells of the soft tissue involved in the ossification by some sort of metamorphosis which has been variously conceived. Some suppose that the cells become the lacuna, and send out branches (like the pigment cells) to form the canaliculi (Schwann[1]). Others think that it is not the cell but its nucleus that undergoes this change, and that the substance of the nucleus is afterwards absorbed, leaving the lacuna (Todd and Bowman[2])." The nucleus described by Todd and Bowman is identical with that which in this communication is called the granular cell, and from which the authors have shown the lacuna is formed. "Henle[3] thinks that the lacuna is a cavity left in the centre of a cell which has been partially filled up by calcification, and that the canaliculi are branched passages, also left in consequence of the unequal deposition of the hard matter, as in the instance of the pore cells of plants." "It rather appears to me as if the lacunæ and canaliculi were little varieties left in the tissue during the deposition of the reticular fibres, as open figures are left out in the weaving of some artificial fabrics (but not within a cell, as Henle imagined), and that thus the apposition of the minute apertures existing between the reticulations of the lamellæ gives rise to the canaliculi." "At the same time it seems not unlikely that a cell or a cell-nucleus may originally lie in the lacuna or central cavity, and may perhaps determine the place of its formation." Hassall[4] agrees with Schwann, while Gerber[5] and Bruns[5] appear to hold the views of Todd and Bowman. With the exception of Dr. Sharpey, the above-named authorities may perhaps differ more in the use of terms than in matter of fact. The appear-

1 "Mikroscopische Untersuchungen."
2 "Physiological Anatomy."
3 "Anatomie Générale."
4 "Microscopic Anatomy of the Human Body," p. 310.
5 "Allgemeine Anatomie."

"The process of growth may be thus described. In the meshes of the fibrous tissue on the surface of the bone, *osteal cells* are developed and gradually take its place; a few cells become developed into lacunal cells; the earthy salts are added, and concurrently lacunæ and canaliculi are formed; we then have bone presenting the usual characters of that tissue. (1) In bone developed in the foregoing manner, we find the canaliculi not merely extending to the surface of the cell-wall, or anastomosing with the canaliculi of lacunal cells lying in contact with it, but extending freely in all directions, and passing through or amongst the ossified cells, and establishing rich plexuses of anastomosis. Indeed we see the boundary of the original lacunal cells only in those cases where the lacunæ have but few, or are entirely devoid of canaliculi. It would appear to be a law, to which there are few if any exceptions, that when anastomosis is established between adjoining lacunæ, the lacunal cells blend with the contiguous parts, and are no longer recognisable as distinct

ances would at first view seem to justify the opinion expressed by Dr. Sharpey, but a careful examination of the tissue during its development, the unquestionable fact that in the development from cartilage the granular cell becomes converted into a lacuna, together with the circumstance that lacunal cells are frequently found in the Haversian canals and cancellated structure, especially in the bones of old subjects, and at times imbedded in the structure of the bone, have left no room for doubt in the authors' minds that the lacunæ are formed from special nucleated cells, in the manner described in the text.

(1) When speaking of the growth of cartilage, it was stated that the bulk of that tissue at the epiphysis increased laterally by the division of the cells, but the fact that it also increased on the free surface of the greatly enlarged cartilaginous epiphysis of the fœtus by a process similar to that by which the diameter of bones is increased, was reserved to be described in connexion with the latter subject. If a longitudinal section be taken from the epiphysis of a fœtal long bone, including some portion of the perichondrium, it will be seen that the cartilage passes gradually into a more or less fibrous tissue, which forms the exterior of the part.

bodies. The process by which the cylindrical bones are increased in diameter is in all essential points similar to that described as pertaining to the growth of flat bones. Similar osteal and lacunal cells are present, but the relative amount of the matrix is greater; moreover the osteal cells have a disposition to assume a linear arrangement corresponding to the direction of the laminæ of the contiguous bone. In these lines the cells are placed so close to each other as to leave but little room for intervening tissue, but between the lines an appreciable amount may be recognised. This appearance, however, varies in different specimens. In one the cells predominate, in another the transparent tissue is the more abundant. Generally the younger the animal the greater will be the amount of the intervening transparent tissue, and the smaller the number of the osteal cells. But in all cases, whatever the age of the subject, or from whatever part of the skeleton the specimen be taken, the cells and the intermediate tissue become blended in the process of ossification, and the whole presents a uniform granular appearance, excepting in the instances in which lamination is strongly developed, or in those which have been noticed in the previous part of the paper. We frequently find portions of bone where the osteal cells, lacunal cells, and intermediate tissue are so perfectly fused together that neither can be recognised, but in their place we have a minutely granular mass, divisible only into lacunæ and canaliculi and the tissue in which they lie imbedded."(1)

(1) "Observations on the Structure and Development of Bone." By John Tomes, F.R.S., Surgeon-Dentist to the Middlesex Hospital; and Campbell De Morgan, Surgeon to the Middlesex Hospital.

The foregoing description of the formation of primary bone developed in connexion with fibrous tissue might, with but slight modification, be applied to the development of the cementum, whether the amount of that tissue may be normal or abnormal. Mr. Shelley having been the last to write upon the subject of dental exostosis, his account of the formation of the new tissue may be taken as embodying the latest views.

"Upon examining the periosteum of a stump or tooth recently drawn which has been the subject of long-continued irritation, we find it much more vascular than usual; in some places it is very much thickened and slimy, and very frequently adhering to it are reddish fleshy shreds or masses, which have been called coagulated lymph. These are sometimes of comparatively large bulk, especially where this has been the subject of recent inflammation; and it not only follows that the tooth must be elevated in its socket, but that even the latter must be itself excavated to accommodate the morbid growth. And in order to assist our conception of this fact, I may here remark upon the extraordinary facility with which the jaw-bones change their shape. An alveolar abscess hollows them out, and drills a hole through them in a few days; or two or three double teeth are extracted, and in a few months not a vestige of their former implantation is visible, and they will slowly expand before a tumour, covering it with a thin papery envelope, rapidly to collapse again after its removal into a firm bony ridge.

"Let us now investigate more closely a mass of this so-called coagulated lymph. It is soft, almost diffluent on the

surface; in the middle it is somewhat denser, and at its union with the fang, which is extremely firm, it is of a gristly cartilaginous texture. The smaller and whiter shreds on the periosteum also partake of the latter character, being tough and less vascular.

"Examined by the microscope, the external soft surface is seen to be principally composed of large corpuscles, granular and nucleated, and which in water swell up and burst after a time. The more diffluent parts are entirely composed of these spherical bodies, which agree in character with those corpuscles usually met with in parts recently inflamed, and termed by some exudation corpuscles. In addition to these, small masses of a granular blastema are also visible.

"The principal constituent of the next undermost portion is seen to be fibrous tissue in a state of formation. For here may be seen (and in some instances it is most admirably shown) oval corpuscles with fibrous prolongations, some with a short fibre at one end, others lengthened out at both ends, and putting on the characteristic undulation. The corpuscles are light, and generally bi-nucleated, whilst the fibrous extensions are slightly more opaque.

"Still nearer the fang we find the mass tougher, and composed of fibrous tissue, but mingled with it amorphous granules of a gelatinous appearance, and in the meshes, and floating about the margins of the mass, are a number of oval cells.

"At its junction with the fang the substance becomes dense; it is torn with difficulty, and under pressure slips about between the two glasses, and refuses to be flattened out. Under the microscope it appears as a solid, amorphous,

yellowish mass, in which, however, may be still distinguished the wavy appearance of the fibrous tissue.

"In this dense gelatinous substance, osseous matter, which has been detached from the fang along with it, may be seen; not, however, shooting out into it in the form of spiculæ-like ossification in the fibrous matrix of the bones of the skull, but as rounded amorphous molecules.

"A more careful examination of the cells found floating freely in the field of the microscope around the margins of preparations made from the two last-described modifications of the so-called coagulable lymph, and which may also be distinguished imbedded in the masses themselves, shows them to be, from their shape and size, identically the same cells, but with different contents, and these contents singularly agree with different modifications of tissue above described. For instance, cells may be seen particularly abundant in the middle of the 'coagulable lymph,' of an oval or elliptical shape, transparent, homogeneous, and furnished usually with two nuclei. Then they may be seen with faintly granular contents and larger nuclei; and lastly, their interior seems stuffed with a more opaque and denser substance, disposed in large granules, among which the nuclei cannot positively be pointed out.

"When a fang to which these masses of so-called coagulated lymph has been allowed to dry; or still better, if a section be made, it is at once evident that the spots to which they were attached are the seat of a preternatural deposit of cementum; and a thin transparent slice submitted to microscopic examination shows the extra-cemental deposit as I

have above described it, and also the fibrous matrix still adherent to its margin, in spite of the rough usage to which it has been subjected in preparing the section."(1)

On comparing the statements made by Mr. Shelley with those contained in the previous extract, it will be seen that there are no essential points of difference recognised in the mode of formation of bone and cementum. In each case cells are produced, the individuality of which becomes lost in the process of calcification, together with the fibrous matrix.

In the soft tissue which connects the root of a tooth with the walls of the socket, Mr. Spence Bate considers that two distinct structures may be traced,—the peridenteum of the tooth and the periosteum of the bone. The former he regards as a dermal tissue, the latter as belonging to the internal or osseous system, and states that "however closely in juxtaposition the two may approximate, they still hold their relative connexion widely apart." (2) The cementum he regards as a production of the inner surface of the peridenteum, and as in no way connected with or dependent upon the periosteum of the socket, the two membranes being incapable of ossific union; a statement which he considers is justified by the fact that the root of a tooth, although the subject of exostosis, never becomes anchylosed to the jaw. Had periosteum alone intervened between the tooth and the socket, an osseous union would, it is assumed, have occasionally taken place. Although the presence of the two membranes

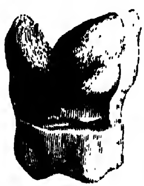
(1) "Transactions of the Odontological Society," vol. i.

(2) "On the Peridental Membrane in its relation to the Dental Tissue." By C. Spence Bate, Esq.

may be assumed to exist, it would, I think, be extremely difficult to demonstrate them individually, either in a healthy or in a diseased tooth, the root of which had attained its full dimensions.

When a disease consists in the mere increase of a tissue, the presence and position of which are normal, the transition from health to disease is imperceptible, and is usually destitute of symptoms. It is only when the amount of new tissue has attained a considerable thickness, that distinct symptoms are developed, and even then they are in many cases absent. In dental exostosis, a distinction must be drawn between those cases in which the disease is consequent upon pre-existing disease in the tooth, followed by marked irritation of the alveolar membrane, and those in which it is developed independently of any other disease.

Fig. 164. (1)



When the disease arises in connexion with caries, it is attended by a thickening of the gums, which assume a deep dull colour, and a disposition to bleed when subject to friction either from the tooth-brush or food. But when the crown of a tooth is free from disease, exostosis of the root may be unattended with any recognisable change in the condition of the contiguous gum. The occurrence of sympathetic pains in the head, face, or neck, may be, and often are, the only indications of disease. In the presence of such pains it is often extremely difficult to determine whether the teeth are in fault, and if so, which tooth or teeth have occa-

(1) A molar tooth of the upper jaw, the roots of which are thickened by the addition of cementum, the crown being free from disease.

sioned the suffering. Sooner or later local symptoms may arise by which the offender can be recognised. The tooth will become tender on pressure, or sensitive to the effect of hot or cold fluids, or the gum may become absorbed, and leave exposed the neck of the tooth, which eventually becomes loose. Such obvious symptoms, however, commonly appear only after the patient has undergone great suffering from assumed idiopathic tic-douloureux, a complaint for the relief of which patients have submitted to have tooth after tooth extracted, although the relief afforded after each operation was but questionable.

There are cases, however, in which the presence of exostosis, even of slight amount, produces great misery: a certain tooth is pointed to by the patient as the cause. Its removal brings relief. The complaint returns, another tooth is fixed upon, and removed with a similar result. Another and another follow; and it is only after all the teeth in the upper or lower jaw have been removed that the patient gains permanent immunity from pain. A case which followed this course came under my treatment six years ago, and it is scarcely eighteen months since the last tooth was removed. The crowns of the teeth were sound, but the roots had become slightly enlarged by exostosis. The patient, when she first consulted me, stated that she had suffered from tic-douloureux for several years, and had submitted to the usual treatment without advantage. Two teeth had been extracted, and the operation was followed by a remission of the symptoms. The pain however soon returned with full severity, and at the time she came under my charge two upper bicuspid teeth were regarded as being connected with the pro-

duction of the disease. She stated that the pain came on gradually at irregular intervals, lasting sometimes for twelve or fourteen hours, or until, exhausted by suffering, or narcotized by opium, she fell asleep. The suspected teeth appeared quite healthy, but the patient stated, that though they did not ache, yet that they were seldom free from an uneasy sensation. She always felt that they were there, and prior to an attack of facial pain they became hot and felt full. Leeches were applied to the gums, and internal remedies administered, but without producing any mitigation of the symptoms. After a time the teeth became sensitive to the effects of changes of temperature, and a current of cold water or air not only produced pain in the two teeth, but also brought on an attack of pain in the face. The teeth were extracted, and for several months the patient was comparatively free from pain. Other teeth became similarly affected, and were removed with similar results; but it was only after the whole of the teeth of the upper jaw had been extracted that the patient became perfectly free from the recurrence of the disease. In another case the patient had suffered for several years from intermittent pain in the head and face. For a long time the cause of the disease appeared to have a constitutional rather than a local cause, but the usual remedies failed to afford relief. After a time a feeling of uneasiness attracted attention to the only remaining molar tooth, the second molar of the upper jaw, situated on the side in which the pain was felt. On removal the crown was found to be sound, but the roots of the tooth were enlarged. In this, as in the preceding case, the liability to pain in the face ceased after the operation.

In the two cases cited the relief was complete, although by no means instantaneous. The pain became gradually less severe, and the attacks less frequent, and shortly ceased to recur.

It may be stated generally, that the removal of a tooth which has been the cause of sympathetic pain, usually produces a severe attack, the paroxysm bearing some relation in its duration and in intensity to the previous attacks, and to the length of time during which the disease has existed.

The sympathetic affection may however, in a few rare examples, extend to a derangement of the whole nervous system. Two cases have occurred under my own observation, in which epilepsy was consequent upon diseased teeth, the most prominent feature being exostosis of the roots.

A lad, a farm labourer, from Windsor, was admitted into the hospital for epilepsy. The usual remedies were tried for six weeks without effect. His mouth was then examined, and the molar teeth of the lower jaw were found to be much decayed, and of some of these the fangs only remained. He did not complain of pain in the diseased teeth, or in the jaw. The decayed teeth were, however, removed, and the fangs of each were found to be enlarged and bulbous from exostosis. During the eighteen months that succeeded the removal of the diseased teeth, he had not suffered from a single fit, though for many weeks previous to the operation he had two or three per day. This is a case of singular interest, inasmuch as there was no complication of maladies, and hence there could be no doubt as to the cause of the disease, seeing that it immediately subsided when the teeth were re-

moved; and it is further useful, in showing that a sufficient source of local irritation to induce functional derangement may exist without pain being felt in the part where the irritation is applied.

A similar but less marked case occurred shortly afterwards in the person of a policeman. He had fits, which were greatly relieved by the removal of an inferior wisdom tooth, the subject of caries and of exostosis.

The abnormal growth of the cementum is, as compared to exostosis of bones, confined within very narrow limits. The size of the root of a tooth may be doubled, and two contiguous teeth may become united by the development of cementum about their roots, but we never see a great mass of new tissue produced. A specimen in the Museum of the College of Surgeons exhibits the largest growth of cementum I have ever seen. It projects from the neck, and forms a process almost as large as the implanted portion of the tooth.

I am indebted to my friend Mr. Spence Bate for the following illustration, and for the loan of the specimen from which it was taken. The amount of hypertrophy is here very considerable, and has not only connected the two roots of the tooth, but also the remaining stump of a contiguous tooth, the crown of which had been previously lost.

Fig. 165. (1)

Through the kindness of Mr. Martin, of Portsmouth, I am

(1) Showing exostosis in a lower molar tooth, uniting the two roots and the stump of a contiguous tooth. From a specimen in the collection of Mr. Spence Bate.

enabled to add an example in which the second and third upper molars are united by the abnormal development of cementum.

Fig. 166. (1)

Although numerous instances may be found where two teeth have become united by cementum developed under circumstances which constitute its formation a disease, yet in no well-authenticated instance has the cementum become continuous with the bone of the socket. In reptiles the anchylosis of the teeth to the jaw is a normal character, but in the human subject a case is yet wanting to show that anchylosis between the teeth and the jaw is under any circumstances possible. In two tissues so similar to each other in structure that their distinction is often attended with difficulty, we should be able to point out why their separation in the presence of disease is always preserved when contiguous bones placed under similar circumstances become so readily united.

If we examine a case of local disease in a bone,—a phalanx, for example, in which the vitality is at one point lost—we shall find an opening through the integuments from which pus is discharged; extending from this point, the skin and periosteum will be inflamed to a certain distance, the diseased gradually merging into the healthy tissues. If an opportunity of a careful examination be afforded, it will be found that where the dead joins the living bone, the latter is

(1) Showing the second and third molar teeth of the upper jaw united by the abnormal development of cementum. I am indebted to Mr. Martin for the use of this rare specimen.

undergoing absorption, and that beyond this point new osseous tissue is becoming developed upon the surface of the pre-existing bone, the latter part corresponding to the junction of the healthy and the diseased soft tissues, and the former to the part where the skin exhibited all the indication of chronic inflammation. In a tooth, the periosteal investment of which has become inflamed, conditions in many respects similar to those which take place in bone may be observed. Thus the end of the tooth will be denuded of periosteum, and in some cases diminished in bulk by absorption. Higher up the membrane will be adherent and thickened, and beneath this the cementum also will be increased by recent additions of new tissue. In order to allow of the increased bulk, the alveolus is necessarily enlarged. Still, the interval which separates the wall of the socket from the contained root is small, and might readily become the seat of bone uniting the tooth to the jaw, but for the existence of a law which prohibits the union of the tooth to the jaw, while it allows two bones, when similarly placed, to become connected by ossification.

The exciting cause of exostosis is sometimes very obscure. On other occasions it is sufficiently obvious. In a tooth which has been worn down to the level of the gum, the periosteum becomes irritated to an extent sufficient to induce the development of cementum. Again, in teeth attacked by caries, a similar result may follow.

But to whatever cause the disease may be attributed, the treatment will be the same. The extraction of the diseased tooth is the only remedy upon which we can depend.

Necrosis.—When a part or the whole of a tooth has lost

its vitality, the condition is expressed by the term necrosis. The disease involves the death, but not necessarily the decomposition, of the dead part, the tissues of which become discoloured, but are seldom softened.

The term is no doubt associated in the minds of many practitioners with that state which is attended with discoloration of the whole of the crown of the affected tooth. But the discoloration of a dead tooth is, strictly speaking, an accidental and by no means necessary coincidence. It depends, in the first place, upon the pulp losing its vitality when its vessels are filled with blood, and upon the ultimate decomposition of the blood-globules, and the solution of the colouring matter in the fluids present. These permeate the dentine, and impart to it a permanent stain, the discovery of which is looked upon as an infallible indication that the tooth is dead. The loss of the normal colour is obviously a mere consequence of the death of the pulp under certain circumstances, and a consequence which takes some time to develope.

The depth of the stain will also be varied, the variation depending upon the age of the patient. The younger the subject, the larger and more vascular will be the pulp, and the deeper the stain produced by its decomposition. In old people, on the contrary, the pulp is relatively small, and the discoloration of the tooth consequent upon its death is but slight, and may, in fact, be altogether wanting.

A perfectly dead tooth is soon thrown off by nature as an extraneous body, its expulsion being attended with more or less local inflammation of the surrounding soft parts. The amount will to a considerable extent depend upon the relations of the several parts involved at the time the

death of the tooth takes place, and upon the cause which produced it.

If, for instance, the alveolus and the gums have receded, the inflammation excited by the dead tooth will not be great, unless the death of the tooth has been consequent upon inflammation of the pulp and of the dental periosteum. Even then the symptoms will be less severe than they would have been had the alveolus and gum risen to the usual level. But we see many discoloured teeth which have remained for years firmly implanted in the jaw, and their presence has been unattended with serious inconvenience, yet they may be described correctly as necrosed teeth. In such cases the disease has not, however, involved the whole of the tooth; some part has retained its vitality, through which the connexion with the soft tissue has been maintained, and consequently the tooth has been enabled to hold its place. The circumstance that a tooth, the crown of which presents all the external characters peculiar to a dead tooth, retains its position, and in certain cases fails to produce considerable local disturbance in the jaw, while in other instances great irritation is set up, indicates that the disease is subject to important modifications, which at first sight are not very apparent. On investigating a series of cases, it will, however, be found that the modifications which they present are consequent upon the extent to which the tooth has become involved, rather than to any special difference in the disease. Thus the dentine may lose its vitality in consequence of the pulp having been destroyed, and the tooth assume the peculiar brownish red colour which arises from the decomposition and diffusion of the blood contained in the pulp through

the dentine, and yet the cementum may retain its connexion with the periosteum. This connexion affords the means by which the tooth may retain its place for an indefinite period. Examples are often seen in which the pulp has been suddenly destroyed by a blow received many years previously, and the injury has been followed by discoloration of the crown of the tooth. The patient will state that the tooth is dead, but this is not strictly correct; the death has been limited to the dentine: the cementum has retained its vitality, although its normal state may not be perfectly preserved.

Again, in pivoting a tooth we reduce the root to a similar condition. The vitality of the dentine is sacrificed when the pulp is destroyed, but if the operation is attended with success, the life of the cementum will be maintained.

The time during which a tooth so circumstanced will retain its position without undergoing further change, is not unlimited. I believe that the cementum becomes the seat of an increased if not a morbid action so soon as the vitality of the dentine is lost. In some cases great additions are made to its surface, and through the new tissue the connexion with the periosteum is preserved. In others, again, absorption is set up, and the root becomes reduced in bulk, is gradually detached from the periosteum, loosens, and falls out. In the former case the living portion of the tooth appears to be very limited in amount, its extent being often confined to the newly added tissue; for the appearance presented by some specimens would justify the conclusion that the cementum which existed at the time the dentine lost its connexion with the soft parts, though not deprived of life concurrently with the dentine, yet subsequently lost its vitality, but not,

however, before new cementum had been added upon the surface of the older tissue.

If we remove a tooth which has been the subject of the foregoing changes, and allow it to become dry, those portions of cementum which are of comparatively recent formation, will present the opaque white aspect of healthy bone; while the other parts of the tooth, including the older cementum, exhibit more or less discoloration. Now, it is possible that the whole of the tooth became necrosed at the same time, but it is more probable that the death of the cementum was subsequent to the death of the dentine, and also to the development of a new layer of cementum. Otherwise it must be admitted that the living tissue was developed upon, and united to, and continuous with, the dead structure.

Necrosis may, however, be confined in the first instance to the cementum, the dentine and dentinal pulp retaining their normal relations. In cases which present this character the tooth becomes loose, and the gum usually, although not necessarily, recedes. The surface of the cementum is detached from the periosteum, excepting perhaps at and about the extremity of the root where the nerves and bloodvessels pass into the pulp-cavity.

The patient complains of intermittent pain in the tooth, excitable at any time by the application of hot or cold water; very commonly pus will escape from between the tooth and the gum when the latter is pressed. The crown of the tooth does not assume the dark slate colour which follows after the death of the pulp. In this form of the disease additions are not made to the cementum, unless in small and isolated spots. Generally the cementum is greatly

reduced by absorption, and even the dentine in many cases suffers also.

I remember a case in which seven front teeth lost their attachment to the socket, excepting where the nerves and bloodvessels entered the root, without the vitality of the pulp having been sacrificed or the gums absorbed.

There is yet another form of partial necrosis. One root of the double-rooted teeth, or one or two of the treble-rooted teeth, may become dead and perfectly detached from the lining membrane of the alveolus, while the remaining root or roots preserve their vitality. Teeth when in this condition are apt to be at times very troublesome. When they are used in mastication pain is experienced from the dead root being pressed into the socket, the lining membrane of which is injured by the rough surface usually presented by the dead root. The continued irritation arising from this cause is productive of thickening of the alveolar covering, accompanied by the development of a high degree of sensitiveness in the hypertrophied parts, the susceptibility to pain in which is consequently increased. Hot or cold fluids taken into the mouth also excite pain in the tooth itself, or in the irritated alveolus (it is very difficult to say in which). The alveolus and gum of the dead root may or may not become absorbed.

In one case we may see the whole of the root, even to its extreme point, laid bare by the removal of the investing parts, and in another case the gum will maintain its normal height. Of the two, the former condition is preferable, on account of the greater degree of irritation and pain which usually attend the latter.

The thickened periosteum, if adherent at any point to the

cementum, may be, and sometimes is, withdrawn from the socket on the tooth being extracted. It is usually light in colour, of considerable thickness, and almost as dense as fibro-cartilage.

In respect to the treatment of either partial or complete necrosis of a tooth but little can be said, further than that so soon as the diseased organ becomes a source of serious annoyance, it should be removed.

Any attempt to restore the vitality of the part would be useless. The gum and periosteal covering of the neck and roots of a tooth having lost their attachment, never become reunited.

Absorption of the roots of permanent teeth.—The removal by absorption of more or less of the root in teeth the crowns of which have been injured by disease, has been already mentioned; but cases from time to time arise in which, while the crown of a tooth is perfectly sound, the root is attacked by absorption. It is to absorption, when it occurs under the latter circumstances, that attention will be directed.

Although the processes of absorption will be the same under whatever circumstances they may be set in action, yet we may arrange the cases under two divisions, in accordance with the character of the exciting cause. In the first may be placed those examples in which the whole or part of the root of a sound permanent tooth is absorbed without reference to the growth of an adjoining tooth; and in the second, those cases where a portion of a permanent tooth is absorbed to make way for the eruption of a neighbouring tooth.

I have seen many cases of absorption in permanent teeth, where the waste has so far reduced the root that they

became loose and painful; but I am indebted to Mr. Canton and to Mr. Brookhouse for specimens showing complete absorption of the root. In the one case the central incisors, one after another, became loose, and fell out, on the younger side of forty, just as though they were temporary teeth making way for their successors. In the other, a permanent lateral incisor was lost under similar circumstances.

Fig. 167. (1)

In neither patient was there any indication of the presence of disease, either in the gum or in the alveolar process. The attention was attracted by no other symptom than the gradually increasing looseness of the tooth. In a patient of my own, an upper central, at the age of fifty, became rather suddenly loose and painful. It was subsequently found that the one side of the root had been removed by absorption, the process having been arrested when the walls of the pulp-cavity were reached, leaving the pulp perfectly encased in a thin tube of dentine. But for the supervention of inflammation, followed by the secretion of pus, it is probable that in this, as in the preceding cases, the whole of the root would have been removed.

Fig. 168. (2)

The fact that the walls of the pulp-cavity resisted the absorbent action with greater force than any other part of the dentine, accords with what we may observe takes place in a limited degree in temporary teeth. It is probable that the

(1) Permanent central incisor, the root of which has been absorbed: from a specimen placed at my disposal by Mr. Alfred Canton.

(2) A permanent incisor, one side of the root being removed by absorption. A thin case of dentine enclosing the pulp has been preserved.

presence of the pulp gives this power of resistance; for in pivoted teeth the root is commonly reduced by absorption, and perforations are sometimes made, by which the metal pin is exposed. The process of absorption having been discussed in connexion with the shedding of the temporary teeth, it need not be again entered upon.

Fig. 169. [1]

The cases which fall under the second heading are usually dependent upon the malposition, and consequent retarded eruption, of a permanent tooth. The extent to which the absorption of tissue is carried is usually limited to the production of a slight depression in the neck or root of the tooth, but in a few cases the process is continued until the pulp-cavity is laid open and the pulp exposed.

The canines of the upper jaw being more frequently mal-placed and retarded in their eruption than any other teeth, we should expect to find instances of absorption in the lateral incisors and first bicuspid teeth. But in these we seldom see more than a simple depression, towards which the advancing crown of the coming tooth has been directed. It is upon the second molars that the greatest extent of injury is inflicted. When the crown of a wisdom tooth is directed forwards, it leads to absorption in the neck of the obstructing tooth; and the process, though generally arrested before the second molar is permanently injured, will, in some cases, lay open its pulp-cavity. I have seen several cases in which the injury has been followed by inflammation of the pulp, necessitating the immediate removal of the tooth. In a case which occurred

(1) A pivoted tooth, with the root reduced in size by absorption, and gold pin exposed at one point by a perforation, also produced by absorption.

recently, the patient complained of severe pain in a second molar of the upper jaw. The tooth appeared in every respect sound; directions were therefore given that a leech should be applied to the gum. On the following day the patient returned, complaining that the abstraction of blood had failed to produce relief, and strongly urged that the tooth should be removed. The tooth had become slightly moveable, and the crown had lost a little of the natural brilliancy of colour. After removal, the cause of the suffering was manifest. The pulp-cavity had been laid open, the pulp became inflamed, lost its vitality, and at the time of the operation was in a state of decomposition. In this instance there was not the slightest evidence of caries; but in others which have come under my notice, the cavity produced by absorption subsequently became the seat of caries.

The manner in which the latter result is brought about requires some explanation.

It has already been stated that absorption is effected by a vascular papilla, which advances in front of the moving tooth. In those cases in which decay arises in a cavity so produced, the papilla has been situated but a short distance within the margin of the gum, and the cavity consequently becomes exposed to the fluids of the mouth when the latter parts shrink down to a lower level.

Diseases of the pulp.—No portion or organ of the body, either in health or disease, can be independently considered. Whether an inflamed eye or a diseased tooth form the subject of inquiry, it must be borne in mind that neither can exist but as one of many parts which collectively form the body; that the healthy condition of an organ is due to a cor-

responding state of the whole organism, and more especially to a sound condition of the organs in its immediate vicinity, or with which it is closely associated; and that a state of disease may be consequent upon, or even a symptom of, a disordered state of a neighbouring part of the body. On the other hand, a diseased condition originating in an eye or a tooth, may induce sympathetic affections even in remote organs, and in doing so may seriously disturb the general health. It is necessary that the mutual dependence of the various organs upon each other should be fully acknowledged by those who restrict themselves to special branches of practice, and who naturally feel a strong tendency to isolate and place in an independent position, and to give an exaggerated importance, to the diseases of the one organ or set of organs to which their attention is more especially directed.

These observations admit of application to practitioners of dental surgery, who are strongly tempted to regard local conditions without reference to the general constitutional state, of which they may be but an indication. The remedies which he finds most effective are local in their application and effect. It is only when the character of the disease is somewhat vague, as in the group which is about to be considered, that the attention is called to the general condition of the body.

Irritation of the dentinal pulp.—A diseased condition of the pulp, whatever may be the nature of the disease, is, in the majority of instances, consequent upon the pulp-cavity being laid open, either by the destruction of its walls by caries, or by injury of the crown of the tooth from mechanical

violence. But a few cases will be met with in which the tooth becomes painful, and highly sensitive to the effects of sudden changes of temperature, induced by the contact of hot or cold fluids, and even to slight pressure upon the crown or upon the neck of the tooth, while the walls of the pulp-cavity are free from injury. In such cases the patients will complain that the tooth is incapable of bearing with comfort the pressure exercised in mastication. Careful examination usually leads to the detection of caries, or to loss of a portion of the crown of the tooth, either from wear or fracture. A certain degree of pain is produced by pressing a steel instrument upon the injured spots, but the degree of pain will not correspond to the amount of force exercised; indeed, slight contact seems to give quite as much pain as firm pressure.

But we may fail in detecting any indication of structural change in the sensitive teeth. The disordered state may depend upon some other tooth, which, although itself free from pain, may produce sympathetic irritability in other teeth, or it may depend upon a cause which has a constitutional or general origin. The earlier stages of cold, rheumatism of the jaw, or the presence of mercury in the system, are frequently accompanied by an irritable state of the teeth.

When the foregoing local symptoms are present, it is very difficult to determine whether the sense of pain in the tooth is confined to the dentinal fibrils, or whether it is situated in the pulp, the susceptibility of which has become abnormally heightened. There is no reason for supposing that the fibrils are incapable of assuming a condition of excessive sensibility, and that the morbid state may not for a time be confined to them. But it is quite possible that the increased suscepti-

bility may originate in and be limited to the pulp itself, which becomes painfully affected by causes which otherwise would not produce uneasy sensations.

That a state of irritation may be assumed by the pulp, is sufficiently proved by the fact that the irritable condition of the tooth may be succeeded by inflammation of that organ. Examples of the sequence of the one to the other condition may be seen in teeth, small portions of which have been broken off without injury to the pulp-cavity. When so injured they become gradually sensitive to changes of temperature, and the pain, which at first was transient, at last endures after the exciting cause has been removed. The amount of pain is gradually increased, and eventually terminates in a severe attack of toothache, occasioned by acute inflammation of the pulp. On the aching tooth being removed, it will be found that although the pulp-cavity is entire, the pulp is passing into a state of disorganization. A similar course of symptoms will sometimes follow the operation of plugging a simple cavity in teeth which have been in an irritable condition prior to the operation. No doubt the pulp of a tooth may pass into a state of irritation, independent of injury sustained by the hard and protecting tissues, just as in certain states of the system the susceptibility to disease of any other organ of the body may be increased. But in those cases in which the crown of the tooth has suffered, there appears good reason for supposing that the abnormal state begins in the dentinal fibrils, and extends through them to the pulp. This view is, I think, supported by the results which follow careful treatment. If, in a tooth the crown of which has been injured by caries to a slight

depth only, but in which the dentine is highly sensitive, nitrate of silver be applied to the affected part, the susceptibility to pain will in a few minutes be greatly reduced. A similar result will follow the application of other forms of escharotics, unless the walls of the pulp-cavity are sufficiently reduced in thickness to allow the application to pass through to the pulp. The effects with these active agents are rapid, but their use is not free from danger; for it is not always easy to discover how much or how little sound tissue may intervene between the pulp and the sensitive surface. Excepting as a matter of experiment, or when a sufficient length of time cannot be allowed for the application of less active remedies, it will be well to employ vegetable astringents, such as tannin, or solution of gum-resins in alcohol, and to continue the treatment till the tooth regain its normal state.

In a previous page it was stated that the dentine loses sensation on the pulp being destroyed, and it is now shown that a sensitive surface of dentine loses its power of feeling or transmitting pain after treatment with nitrate of silver. The results thus obtained indicate pretty clearly that we shall not be wrong in attributing a considerable share of the hyper-sensibility to the dentinal fibrils, and the conclusion is still further justified by the fact that if we excise the surface which has been acted upon by the nitrate of silver, the newly exposed surface will exhibit the condition of sensibility, which the application of the escharotic removed from that which was cut away. If the attempt to show that an irritable state of the pulp when connected with a damaged state of the crown of the tooth is preceded by, and consequent on a similar state of the dentinal

fibrils, has been successful, there will be no great difficulty in establishing a strong ground for assuming, that when the teeth become irritable in consequence of causes acting through the system, that, so far as the teeth are concerned, the state of irritability is situated in the pulp itself.

The supervention of inflammation of the pulp, independent of exposure, has been alluded to as an occasional result of irritation. But it more commonly happens that the diseased condition of the dental tissues is allowed to progress, the pulp-cavity is laid open, and the exposed pulp then passes into a state of disease, acute or chronic, as circumstances may determine. If, however, the disease in the crown of the tooth be successfully treated, the state of irritability will by degrees pass away, and the tooth will be restored to a state of comfort and usefulness.

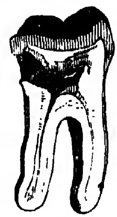
Irritation, if long continued, is usually, but not constantly, productive of certain changes in the pulp itself, examples of which may be seen if teeth removed after a long-continued state of uneasiness has been succeeded by active aching, be examined. In some the pulp will be found to contain numerous nodules of dentine; in others, the greater part of the pulp will be found converted into secondary dentine. (Fig. 170.) Or the calcification of the pulp may be limited to the production of a patch of dentine added to the wall of the pulp-cavity. (Fig. 171.)

Fig. 170. (1)

(1) Showing the pulp-cavity of a first permanent molar of the upper jaw perfectly filled with a mass of secondary dentine, produced by calcification of the pulp, induced by caries of the crown of the tooth.

In neither of the preceding cases can the calcification have been effected during the day or two of acute suffering in the tooth, consequently it may be inferred that the production of secondary dentine took place when the irritable condition prevailed. It must not on this account be assumed that calcification of the pulp invariably follows upon irritable conditions of the tooth, for cases will be found in which the presence of secondary dentine cannot be recognised, and others in which a large portion of the pulp has undergone calcification without the precedence of irritability in the tooth.

Fig. 171. (1)



Treatment.—When the irritability of the tooth is consequent upon the presence of simple caries, our aim must be to introduce a permanent plug; some little caution must, however, be used, otherwise the remedy will but serve to increase the disease. The patient may have sufficient endurance to allow the excision of the whole of the affected dentine, and the subsequent introduction of a gold or other metallic filling, but the presence of metal, from the rapidity with which it transmits changes of temperature, serves, when the tooth is highly sensitive, to increase rather than mitigate the evil. The sensitiveness will, however, in the majority of cases, gradually subside; in others, we shall be required to remove the metallic plug, and substitute a non-conducting material. The prepared gutta-percha will be found extremely useful in the treatment of such cases. Indeed, whenever we find that greatly increased sensibility is established, we shall do well to intro-

(1) Section of a tooth, showing the local thickening of the wall of the pulp-cavity, consequent upon irritation produced by advancing caries.

duce a temporary plug of this material, taking care to substitute gold when the tooth has recovered its normal condition. In many cases, however, the pain occasioned by the excision of the decayed dentine is perfectly intolerable. The application of chloroform, creasote, or camphorated spirits of wine, will lower the sensibility slightly, but no other agent has in my hands been so immediate and complete in its action as a fragment of nitrate of silver introduced into the cavity, and allowed to remain for five or six minutes. Of course, in the front teeth lunar caustic cannot be used, owing to the discoloration which it occasions; but in the back teeth the dark stain is of less consequence. The natural colour of the tissues, even in the molar teeth, should, if possible, be preserved, but not at the risk of losing them altogether. There is another advantage which attends the use of nitrate of silver; it has a power of arresting the progress of decay.

In connexion with a generally heightened sensibility, we sometimes find a ring of decomposing and extremely sensitive tissue encircling the necks of several, or perhaps all, of the front teeth. The operation of plugging is quite out of the question, and the complete destruction of the teeth is therefore reduced to a mere matter of time. Owing to pregnancy or some other cause, it may be desirable to adopt means for allaying the susceptibility of the teeth, and at the same time to preserve them, if possible, for a few months. In the treatment of cases of this description, nitrate of silver has proved very valuable. The author can call to mind many cases in which, by the application of lunar caustic, great discomfort was removed, the presence of hot or cold fluids rendered tolerable, and the teeth, although blackened at the necks,

were kept from further deterioration for five or six years.

It may be said that the foregoing treatment bears rather upon an abnormal condition of the dentine than upon an irritable condition of the pulp; and the objection may in some cases be valid, but it will be almost impossible to distinguish between pain felt in the dentinal fibrils and in the pulp, and the distinction in respect to the treatment is unimportant, unless the ailment has a constitutional origin, when it must of course be treated by remedies which operate through the general system.

Acute inflammation of the dentinal pulp.—The occurrence of inflammation of the pulp is usually consequent upon its exposure, brought about either by caries or the accidental fracture of the tooth. Not that the pulp is more exempt from the occurrence of inflammation than some other soft tissues, but still the cases of idiopathic disease are not very frequent. In ninety-nine cases out of a hundred the diseased action is consequent upon the perforation of the pulp-cavity. The following is the usual course of events:—A hole is discovered in a tooth, food and other matters collect in it, and are from time to time removed. The presence of foreign bodies at first produces no inconvenience, but after a while certain substances, such as sugar, or salt, or acid matters, when lodged in the tooth, occasion considerable uneasiness, which is after a while exchanged for positive pain. The removal of the irritating matter is soon followed by the restoration of comfort. This state of things may go on for some time, but sooner or later the pain, instead of passing off, steadily increases, assumes a throbbing character,

becomes still more acute, extends from the faulty tooth to the neighbouring teeth, and to the side of the face, the tooth forming the centre of its intensity. After the lapse of some hours the pain usually subsides, to return again on the slightest provocation, or on the patient assuming the horizontal position. If a tooth be examined subsequent to two or three, or perhaps even after one severe attack of throbbing pain, the pulp will be found to have lost its vitality, and to have passed, or to be in the process of passing, into a state of decomposition. With the death of the pulp the suffering does not necessarily subside, but the character of the pain will be changed. The throbbing ceases, and in its place a dull heavy pain, with a feeling of tension, is left. The tooth feels too long, and is in fact raised in the socket from thickening of the dental periosteum, consequent upon inflammatory action extending from the pulp to the soft tissue which connects the root of the tooth to the socket, indicating the commencement of an alveolar abscess. If the tooth be allowed to remain in the mouth without adopting remedial treatment, the pain after awhile usually subsides, and the elongation and tenderness of the tooth gradually pass off. The pulp-cavity, on examination, will be found to contain decomposing fragments of the dead pulp, or particles of food, from which will be emitted a peculiar phosphatic odour, an indication that the pulp-cavity of the tooth has been opened, and become the receptacle of a secretion discharged, either from a portion of living pulp, or from the surface of an alveolar abscess.

Such, then, is the usual course of events, when the pulp of a tooth becomes inflamed. The results of inflammation may,

however, be modified by the constitutional condition of the patient; the symptoms may be less severe, or they may be greatly aggravated. In some cases the pain lasts but for a short time, and is comparatively moderate in degree, while in others it is continued for days with great intensity. Again, in one case the alveolar inflammation is absent, and in another the whole mouth becomes affected. Independent of the constitutional state, these differences in effect will no doubt depend upon the condition of the pulp prior to the advent of active disease. The size of the pulp will exercise a very material influence; and the number and size of the globules of secondary dentine within its substance will also tend to modify the severity of the symptoms. Generally, the smaller the amount of vascular tissue involved in the disease, the milder will be the symptoms; it is, consequently, seen that in young people in whom the pulp is relatively large, and the amount of secondary dentine within its substance comparatively small, the suffering is greater, and the inflammation more extended than in older subjects. The size of the aperture by which the pulp is exposed will also influence the amount of suffering which attends inflammation of that organ. Local constriction of an inflamed part, under all circumstances greatly aggravates the pain. In a tooth the pulp is uniformly confined, excepting at the point where the wall of the cavity has been perforated; when the vessels become distended, and the more fluid portions of the blood are effused, the pulp will enlarge at any point where enlargement is possible, and it is consequently protruded through the aperture in the walls of the pulp-cavity. The hole in the substance of the tooth is always much larger than the opening into the pulp-cavity, con-

sequently that part of the pulp which has been protruded through the narrow opening into the larger space may there become enlarged, while the part which connects it with the pulp is constricted.

There are but few of us who do not know something of the pain which results from drawing the air from a carious and aching tooth—or, in other words, sucking it—whereby the atmospheric pressure is taken off the exposed portion of the pulp, leaving the vessels unsupported to withstand the force of the circulation. The immediate result is, that the pulp is forced against or through the opening, and in some cases its vessels are ruptured. The bleeding so produced not uncommonly relieves the distended vessels, and the inflammation is for the time checked. That which we can produce at will occurs, in a greater or less degree, without our intervention; and the amount to which the pulp is protruded, and the degree of strangulation which is induced by the form and size of the aperture in the pulp-cavity, will to some eptent govern the intensity of the pain consequent upon inflammation.

The *treatment* of acute inflammation of the dental pulp must be regulated by the stage at which the disease has arrived when relief is sought, and the general condition of the crown of the tooth and of the surrounding parts. If there is reason to believe that the inflammation has not extended to the alveolar periosteum, remedial treatment may be adopted with a fair chance of success; but should it be found that the pulp of the tooth is passing into a state of disorganization, and that suppuration in the socket has commenced, the removal of the tooth offers the only certain and speedy means of terminating the disease. If from any cause

that operation is rendered objectionable, the pain which attends the process of suppuration may be mitigated by the use of decoction of poppy-heads held in the mouth, and by making a free opening over the root of the tooth, so soon as pus is formed. One or two leeches applied to the gum will oftentimes be attended with advantage, but I have not uncommonly been disappointed in the result. The remedy has aggravated rather than alleviated the suffering, and the formation of pus and its subsequent escape have not been materially hastened. The treatment of alveolar abscess will, however, form the subject of a future section, and the treatment for the preservation of a tooth so affected will be there discussed.

If, however, the disease be limited to the pulp, we have yet to consider whether the crown of the tooth is in a sufficiently good state to render its preservation desirable, or whether, in the case of a front tooth, the root should be saved to support an artificial crown, secured by means of a pivot. In deciding these questions, the general state of the gums, the idiosyncrasy of the patient, and the condition of the tooth in respect to the state of development of its roots must be taken into account.

If the gums are in a thickened and unhealthy state, or if the patient be liable to neuralgic pain about the face and jaws, or should there be reason to suppose that the roots are not fully developed, and the aperture at the extremity of each root contracted to its ultimate size, it will be well to remove the tooth. In the absence of any disqualifying condition, we may adopt a plan of treatment for the preservation of the tooth. That plan will consist in the application of an escharotic for the rapid destruction of the pulp, with the

view of filling the pulp-cavity, and making good the injured portion of the tooth by means of gold, or some other material Arsenic, when applied in the manner already described, will be found to be the best agent for bringing about the result. The pain produced by the disease is seldom increased by the arsenic; indeed, it is not unusual for the violent throbbing to be almost immediately exchanged for a dull aching sensation, which passes away in the course of four or five hours.

Chronic inflammation of the dental pulp may arise independently of caries, or of the mechanical injury of a tooth, but practically its occurrence may be assumed to be consequent upon, and almost invariably coincident with, the presence of an opening into the pulp-cavity. It differs from the acute form of the disease in the less active character of the symptoms, and also in the results to which it leads. The pain is seldom long-continued, or very intense when present. It generally comes on at irregular intervals, a periodical character being observed in exceptional cases only. A sudden change of temperature, the application of an irritating substance, such as salt or sugar, will generally bring on a paroxysm of pain, which may endure but for a few minutes, or may last for several hours.

On carefully examining a tooth which gives rise to the foregoing symptoms, it will be found that the pulp at the exposed point has assumed a deep red colour, is extremely sensitive when touched with an instrument, and bleeds very readily. If the tooth be removed, and the crown broken through so as to expose the pulp, it will then be seen that the inflammation has been limited to that part which was exposed, the remaining portion of the organ having retained the normal pale colour. Had the disease assumed the acute form, the whole

substance of the pulp would have been injected with blood, the exposed part being distinguished by the greater intensity of its colour.

In tracing the several consequences of chronic inflammation, the first which should attract attention is the change in the character of the exposed portion of pulp. It becomes for the time being an organ of secretion; purulent or serous fluid is poured out from its surface, the amount and character of the discharge varying with the general health of the patient, and the degree of irritation to which the diseased part has from time to time been subjected.

Supposing this abnormal condition to be established, the presence of pain is not a necessary consequence; and it is important that the fact should be kept in view, for should it be assumed that the pulp is not exposed because the patient has not suffered from toothache, and a plug be introduced, it is highly probable that the tooth will be lost. The discharge will be blocked in by the plug, and its accumulation will, in the course of a short time, bring on an attack of acute inflammation of the whole pulp. It is therefore of great consequence, before proceeding to treat a carious tooth, to ascertain whether the pulp be exposed or not. The history of the case will not always determine the question, and the position of the tooth, or of the cavity in it, may be such as to render a satisfactory inspection difficult. The presence, however, of that peculiar phosphatic odour to which allusion has been already made, is a tolerably sure indication that the pulp is exposed, and that a secretion escapes from its surface; and it is moreover a sufficient warning to abstain from the immediate introduction of a permanent plug.

A second result of chronic inflammation is the formation of

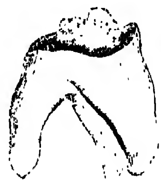
an ulcer, of a very painful and irritable kind, upon the exposed surface; and a third consequence is the development of granulations, which may grow until a mass is formed exceeding the size of the pulp itself, and in some cases completely filling up the cavity produced by the destruction of the enamel and dentine. This condition is usually described as polypus of the dental pulp. The morbid growth is not necessarily very sensitive. It bleeds readily, and emits a very offensive secretion.

There are other results which attend chronic inflammation of the pulp. One consists in the gradual disappearance of the pulp without pain, and consequently without any symptom which attracts the attention of the patient. The practitioner finds the pulp-cavity empty.

The results of inflammation hitherto mentioned are destructive in their tendencies, but the presence of disease is usually attended by reparative efforts. The development of nodules of dentine in the pulp is almost invariably coincident with the occurrence of caries; and there is no reason for assuming that the process of formation is arrested in the comparatively healthy portion, although the exposed surface of the pulp be inflamed. But there seemed some reason to doubt whether the exposed surface could undergo calcification. Mr. Arnold Rogers has recently placed at my disposal a preparation which, I think, sets the question at rest. A patient applied to have the roots of a first molar removed, the crown having been broken off many months previously when, for the relief of pain consequent upon caries, the extraction of the tooth was attempted. The pain ceased after the fracture, and the roots of the tooth were

allowed to remain. After the lapse of some months, the remains of the broken tooth caused annoyance, and they were removed. The specimen (Fig. 172) shows that the tooth was broken through about the middle of the pulp-cavity, projecting from which we now find a mass of secondary dentine. It not only projects from the cavity, but hangs over and conceals the sharp edges produced by the fracture. It is obvious that in this case the vitality of the pulp was maintained, that it became enlarged subsequent to the unsuccessful operation, and afterwards calcified.

Fig. 172. (1).



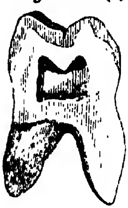
There is no evidence to show that secondary dentine can be formed in any other tissue than dentinal pulp. In the case under consideration, the secondary dentine passes over the normal boundary of the pulp-cavity; we are therefore justified in assuming that the pulp itself became enlarged. Now the tooth had ached before the primary operation was performed, and it may therefore be taken for granted that the pulp was at that time more or less inflamed. These facts, although taken from a single case, warrant the conclusion that there are circumstances under which the dentinal pulp, although it has been diseased and exposed, may be converted into secondary dentine. Having established the fact, the precise nature of the circumstances which favour this reparative action should be determined.

(1) Shows the roots and neck of an upper molar tooth, the crown of which had been broken off in attempting its extraction. Some time afterwards the roots were removed, and it was then found that a mass of secondary dentine projected from and overhung the margins of the remaining portion of the pulp-cavity.

In the case cited the secondary dentine was exposed to view when the patient applied to Mr. Rogers, but the pulp, during the process of calcification, must, I think, have been protected in the first instance by a coagulum of blood, and subsequently by a perfect covering of organized tissue. Had it been otherwise, the pulp would probably have been injured and ultimately destroyed by mastication.

I am not acquainted with any case which can be regarded as strictly parallel to the foregoing, but we may find instances, —if a number of teeth are divided—showing that the bulk of the soft tissue had been calcified, although at the point of exposure the conversion remained incomplete. I believe it not uncommonly happens, that the calcification keeps in advance of the progress of caries, and thus protects the pulp from exposure. But such teeth are not removed, and therefore do not come into our hands for examination.

Fig. 173. (1)



Before the present division of the subject is left, allusion should be made to the fact, that chronic inflammation of the pulp may not be accompanied by pain in the tooth itself, yet that it may cause severe sympathetic pains in the head and face, and that the pain may extend down the neck as far as the shoulder. I remember a case in which the patient suffered severe pain on one side of the head and face at tolerably regular intervals. The pain came on in the evening and lasted for six or eight hours. It was for some weeks regarded as a case of tic, or hemicrania. After internal remedies

(1) A first permanent molar tooth of the upper jaw, the pulp of which was calcified, excepting at its upper part and at the exposed side.

had failed, a decayed but painless wisdom tooth of the upper jaw was removed, and from that time the facial pain disappeared. The pulp of the tooth was exposed and inflamed at a point corresponding to an aperture in the pulp-cavity.

Treatment.—The same general principles that were stated in respect to the treatment of acute must be acted upon in the management of chronic inflammation of the pulp. Remedial measures offer but a very small chance of success if the disease has extended beyond the limits of the pulp, and it would be useless to attempt the preservation of a tooth, the crown of which could not be rendered effective, by filling, unless, perhaps, in the case of a front tooth, the root of which it may be desirable to preserve. In polypus of the pulp, preservative treatment will fail, owing to a coincident enlargement of the aperture at the extremity of the root, and to a morbid condition of the vessels and other tissues to which that aperture gives passage.

If, however, the disease is strictly limited to the pulp, and the symptoms also are strictly local, the chances are in favour of the success if the patient will submit to the necessary treatment. The pulp may be destroyed by arsenic or other means, and the cavity filled; but the strong tendency shown by the pulp to form secondary dentine, and thus shield itself from further injury, should, if possible, be taken advantage of, even though the proceeding may involve a much longer and more troublesome course of treatment than would be required if the pulp were at once destroyed. The preservation of a portion of the pulp, and consequently of the vitality of the dentine, renders the tooth much less liable to attacks of alveolar abscess than it would

have been had the former part been lost. In adopting this course of treatment, we must address our remedies to the exposed surface of the pulp with the view of arresting the discharge to which, when in a state of chronic inflammation, it gives origin. The daily application of camphorated spirits of wine, or of a solution of mastic in spirit upon cotton wool, will, if persevered in, produce the desired effect in the majority of cases. At first the cotton, when removed from the tooth, will be strongly tainted with the peculiar phosphatic smell, but the intensity of the odour will gradually diminish, and after a time altogether disappear. The part of the cotton which has been in contact with the pulp, at first stained by the morbid secretion, will, when the discharge ceases, no longer show any mark of discoloration. Another method of treatment, equally effective, and in my hands more satisfactory, as it requires a less expenditure of time and less frequent renewals of the remedial agent, consists in the application of a soft mass, composed of tannin, mixed with gutta-percha reduced to a gelatinous consistence, with chloroform. The astringent properties of the tannin act in arresting the discharge, while the gutta-percha holds it together, and ensures its contact with the pulp. Although the soft plug will last for some days, it by degrees wastes away; still the renewals are required less frequently than when the cotton and spirit are used.

The treatment having been commenced, the remedial agents, whatever they may be, must be applied uninterruptedly, otherwise the chances of a successful result will be but poor. It is useless to apply an astringent one day, and on the next leave the cavity open and the pulp unprotected.

It will be apparent that where the aperture in the pulp-

cavity is large, any kind of soft plug would, under very moderate compression, adapt itself to and bear painfully upon the exposed surface of the pulp. To this circumstance, and to the want of perseverance on the part of the patients when the teeth admit of preservation, may be attributed many of our failures in the treatment of cases which at the onset promised favourably. Assuming that a successful issue may be obtained, we shall have great difficulty in foretelling the time that the case will be under treatment. I have known instances in which all signs of discharge from the pulp ceased within a fortnight; but I have also met with many examples which were quite uncontrollable either by alcoholic solution of resins or by astringents, or indeed by any kind of treatment short of the actual destruction of the pulp itself. No doubt this uncertainty as to the result is in part due to the difficulty with which the diseased structure is seen, and the state of disease appreciated.

The actual cautery, applied by means of the battery, has recently obtained a certain amount of favour. Some six or eight years since I tried the white-hot wire in the treatment of a considerable number of cases, but failing to produce any permanent advantage, the use of the battery has up to the present time been abandoned. As a means of destroying the whole body of the pulp, it is more pain-producing than arsenic, and less complete in its action, owing to the difficulty which attends the introduction of the wire into the pulp-cavity of the body and roots of the teeth.

Those who advocate the use of the heated wire direct that the exposed surface of the pulp shall be charred, an operation by which a secreting surface is reduced to a dry hard scale,

and therefore for the time deprived of its secreting power. The tooth is now to be plugged, inclosing the burnt tissue; for if we do not proceed to plug the tooth, the eschar will be thrown off, and will leave behind a secreting surface. There will, in fact, be a recurrence to the same state of things that obtained prior to the application of the cautery. But if the tooth be at once plugged, will the eschar separate in the manner which eschars usually separate, that is, by suppuration; or will it detach itself by desquamation? If the treatment be successful, the detachment of the burnt tissue must be effected by the latter process, or it must remain in connexion with the living tissue. In the cases treated by myself, the suppurative process was set up, the attendant inflammatory action extended to the periosteum, and the teeth were consequently lost. It is possible that there are conditions under which the treatment by electric cautery will be attended with advantage; but it is difficult to recognise them, and in the absence of precise knowledge the operator is forced to abandon the use of an agent the indirect result of which he is unable to predict.

When the exposed pulp has ceased to discharge, the sooner the cavity in the tooth is sealed up the better. In conducting the operation, care must be taken both to avoid compressing the pulp and subjecting the tooth to an unnecessary amount of manipulation. The force necessarily employed in producing a gold plug, and the rapid conducting power of an amalgam plug, render each objectionable. The disadvantage which attends the use of the latter may be overcome by capping the pulp with a non-conducting substance. A better result will, however, follow the introduction of a gutta-percha plug. In this material, as prepared for dental pur-

poses, we have a perfect non-conductor of changes of temperature; it is readily applied, perfectly excludes food and saliva, and is easily removed should symptoms of inflammation of the pulp come on. A plug so formed must be regarded as temporary in its effect. It will last for many months, or even one or two years; but so severe a test of its durability should not be tried. If after the lapse of three or four months, the tooth is free from all signs of abnormal susceptibility, the gutta-percha should be removed for the purpose of substituting a permanent plug. It is well not to hurry the final operation, but rather to re-introduce gutta-percha when there is tenderness or any other indication which would throw a doubt upon the capability of the tooth to bear the insertion or the presence of a metal plug.

Although every reasonable precaution be adopted, a certain number of cases, which at the time appeared perfectly successful, will, after the lapse of three or four months, fail. The tooth unexpectedly becomes tender, a feeling of tension comes on, soon to be succeeded by throbbing pain, the usual indications of acute inflammation of the pulp. Either the plug or the tooth must be removed. If the former course be taken, the pulp may be destroyed with arsenic, supposing the disease to be altogether within the substance of the tooth, proceeding in the same manner as in the treatment of acute inflammation of the pulp.

Inflammation of the alveolar periosteum.—The inflammatory affections to which the lining membrane of the sockets of the intra-alveolar periosteum (1) of the teeth is liable, admit of division into the following groups:—

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(1) This term is used to distinguish the periosteum which lines the sockets of the teeth from that which covers the outer walls of the alveoli.

The first will include general inflammation of the alveolar membrane affecting the socket of each tooth, or at all events, the majority of the teeth equally, and dependent for its origin upon a constitutional condition, such as rheumatism, the presence of mercury or some other agent in the system, &c. &c. Local inflammation involving the sockets of one or two teeth, and dependent upon a local cause, will come under the second division.

At the outset of *general inflammation* of the intra-alveolar periosteum, the first indication of the presence of disease is found in the teeth. The uneasiness in the first instance is of that kind which provokes a disposition to grind them forcibly together. For the moment, the pressure of the teeth into their sockets gives relief, but the feelings of discomfort speedily return, and in the course of time they become unpleasantly sensitive to pressure. This is succeeded by a tendency to ache slightly on their temperature being disturbed by a current of cold air passing over them, or by the presence of hot or cold fluids. As the disease progresses, each tooth feels lengthened and loosened, and can no longer be used in mastication without producing a considerable amount of pain. The patient restricts himself to soft food, and takes even that with some degree of caution. If the state of the mouth be examined, we shall find that the disease has extended from the inner to the outer covering of the sockets and to the gums; that the latter are of a dark colour, thickened and vascular, with the free edge more deeply coloured than the surrounding parts. Each tooth may be moved slightly from side to side with the thumb and finger, a condition due to the thickened state of the lining membrane of the socket, and the consequent elevation of the

tooth from its proper level. The severity of the symptoms will vary from day to day, as the general condition of health is better or worse. When the disease is essentially rheumatic in character (and it is to the disease when so modified that the foregoing description is more especially applicable), the inflammation seldom advances beyond a congested state of the vessels, with effusion into the surrounding tissues. It is only in extremely severe cases that suppurative action is established, and in them the secretion of pus is limited to that portion of the alveolar membrane which merges into the mucous membrane at the necks of the teeth. The purulent discharge oozes up between the gums and the teeth, and may generally be rendered visible by making pressure upon the former. The state is altogether different from that of alveolar abscess or gum-boil. In the former the pus is produced at the neck of the tooth, and finds a ready escape; in the latter, it is formed about the root of the tooth, is enclosed within the socket, and has to find its way either by the side of the tooth or through the alveolar wall to the surface of the gum.

Prolonged inflammation of the alveolar membrane may lead only to the absorption of the alveoli, and this, with the consequent loosening and loss of the teeth, is the more common result; but examples are not wanting to show that the suppurative state may, in enfeebled and strumous subjects, be succeeded by ulceration of the soft parts, and necrosis of the alveolar margin, involving perhaps the loss of a considerable portion of the jaw.

I have seen a few cases in which the inflammatory action has ultimately led to the production of large florid granulations. They have sprung up close to the teeth, the crowns of which have been in great part overrun and obscured by the

morbid growth. The patients complained of pain and tenderness in the teeth, and perfect inability to use them in the mastication of food.

When inflammation of the alveolar periosteum is connected with a rheumatic state of the system, the principal indication of the presence of that disease may at times be confined to the state of the teeth and gums, but the abnormal condition of these parts when so affected can scarcely be said to present a specific character. The patient will attribute the visitation of disease to exposure, to a draught, to having taken cold, and will tell you that the feeling of comfort will now, as heretofore, be restored in the course of a few days.

There are, however, cases of inflammation of the alveolar periosteum which present a specific character, have a specific cause, and follow a specific course. One of the effects produced when the system is falling under the influence of mercury, is a congested state of the vessels of the alveolar periosteum. The teeth become tender, elongated, and loose, and the breath tainted with the mercurial fœtor. Let the exhibition of the mineral be continued, and large sloughs will be formed upon the inflamed parts, and portions of the alveoli, with the contained teeth, will be lost. If, on the contrary, the mercury be discontinued when the inflammatory action is, although well marked, moderate in amount, the induced disease will gradually subside.

The following substances are mentioned by Dr. Watson as occasionally producing ptyalism. Preparations of gold, of copper, of antimony, and arsenic; also castor-oil, digitalis, iodide of potassium and opium, croton-oil given internally, and nitro-muriatic acid applied to the surface of the body,

have also been mentioned as occasionally productive of similar results.

Moderate salivation, induced once or twice only, may cause but little mischief, but if the ptyalism be kept up for a long time, or if it be frequently induced, a permanent injury will be inflicted upon the organs of mastication. The production of frequent or prolonged inflammation of the alveolar periosteum will be followed by the absorption of the alveoli, the gums will recede, and the teeth, having lost their implantation, fall out long before their destined time.

The degree of mischief will depend upon the length of time the system has been kept under the action of mercury, but the idiosyncrasy of the patient will exercise a still greater influence. There are those in whom a single dose of calomel or even of blue pill will produce salivation, and the second or third induce the formation of large sloughs, with necrosis of more or less of the alveolar processes. There are others, again, in whom it is extremely difficult to produce ptyalism.

The destruction from sloughing of the soft parts in the alveolar region of the mouth, consequent upon inflammation commencing in the gums and intra-alveolar periosteum, is sometimes so extensive that the cicatrices which follow drag down and fix the cheeks firmly to the maxillæ, and limit the motion of the jaw, depriving the patient of the ability to open the mouth sufficiently for the ready introduction of solid food.

The *treatment* in general inflammation of the alveolar periosteum must, in cases dependent upon a bad state of the system, be addressed to the improvement of the general health. If the local disorder depends upon rheumatism, the

usual remedies for the relief of that disease should be administered; if the malady assumes a strumous type, the remedies best suited for the treatment of struma should be prescribed. If the disease be dependent on an enfeebled state of the body, a generous diet, with quinine, or some other equally active tonic, will prove advantageous.

Cases which partake of the latter character and yield rapidly to generous treatment prevail towards the end of the London season among those who have applied themselves too closely to business.

In aiding the general treatment, local remedies will be found useful. During the stage of congestion, finely powdered tannin may be rubbed upon the gums night and morning, or even more frequently. If the secretions of the mouth are offensive, or if pus be formed between the teeth and gums, a wash composed of eight or ten grains of chloride of zinc to an ounce of water, will afford relief, if held in the mouth for two or three minutes, at intervals of four or six hours. When the inflammation is slight, a solution of borax in eau de cologne forms an agreeable and efficient application; but when suppuration has been established, or when sloughs have formed, the solution of chloride of zinc (the strength of which should be varied to suit the case) will be found to produce a much more rapid and beneficial effect. The fœtor which attends such cases is at once removed by the zinc, and the parts undergoing suppuration, if the general health be improved, are brought into a more healthy state. A state of inflammation having been established from a general cause, is sometimes kept up by two or three defective teeth. Now, whatever may be the nature of the defect, in

the absence of a speedy and complete remedy, the teeth should be removed.

Local inflammation involving the periosteal investment of the roots of one or two teeth.—It will be convenient to consider this subject under the two heads of active, or acute, and chronic inflammation.

Under the former will be placed cases which terminate in alveolar abscess, as distinguished from those cases of chronic disease in which the periosteum remains in a state of inflammation without proceeding to suppuration, excepting at the point where the gum and the periosteum meet. Such cases will fall under the latter division.

Acute inflammation of the dental periosteum, when confined to the alveoli of one or two teeth, usually arises in connexion with, and as a distinct sequence of, pre-existing disease in the involved tooth or teeth. Examples are, however, not wanting to show that this disease may be established in the sockets of teeth perfectly free from caries, and apparently from any other morbid condition. Whatever may be the exciting cause, the symptoms of the disease present but little variety, excepting as respects their intensity, the rapidity with which the different phases of inflammation succeed each other, and the extent to which the neighbouring parts become involved.

The inflammatory action usually sets in with feelings of slight uneasiness and tension, sensations which excite a strong desire to press by the opposing teeth, or to shake with the fingers, the affected tooth in its socket. Slight steady pressure of the fang into the jaw gives relief, but the uneasiness returns on the pressure being withdrawn. The sense of

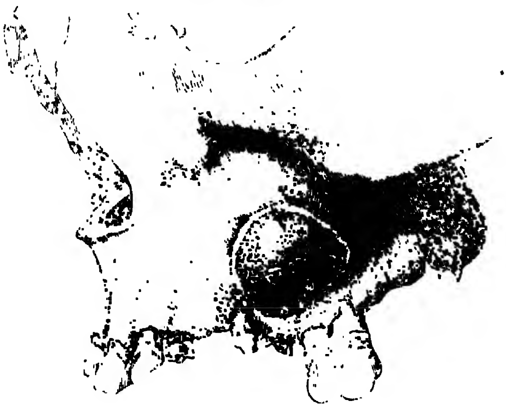
uneasiness is soon followed by a dull heavy pain, and the tooth feels to be longer than its fellows. The desire to move the tooth in its socket continues, till disease has rendered the parts so tender that pressure can no longer be borne, and even the mouth cannot be firmly closed without pain.

The existence of disease within the socket is soon shown in the gum, which becomes swollen and tender opposite the fangs of the tooth whose periosteum is affected. In addition to this latter symptom, and often prior to its appearance, the free edge of the gum assumes a deep red colour, unaccompanied by pain, tenderness, or scarcely any swelling. The neck of the tooth appears encircled with a well-defined red ring. This symptom is usually present in the earlier stage; but as the disease advances the distinction is lost in the general inflammation of the gum. The pain becomes more severe, but still preserves its heavy wearing character, and though not always constant, is seldom absent for many successive hours.

If the progress of the disease be unarrested, the periosteum becomes detached from the cementum, and the point of separation usually commences at, and extends from the foramen in the root of the tooth. Into the interval thus formed pus is poured from the separated surface of the periosteum. The fang at this part loses its vitality, and is bathed in pus, the quantity of which is gradually increased, space being gained in the alveolus for the dilatation of the abscess at the expense of the bone. The extent to which the alveolus becomes excavated will vary with each case. It may be hollowed out to a very limited extent around the apex of the root, or a large cavity may be formed, exceeding in dimensions that which has

been made the subject of the accompanying figure. The size of the abscess will depend upon the activity of the symptoms, the time the pus is pent up, and the state of health of the patient.

Fig. 174. (1)



So soon as suppuration is established a process is set up for liberating the secretion. Either the periosteum becomes detached from the neck of the tooth, and the pus finds its way by the side of the socket and passes out at the edge of the gum, or a perforation is made in the wall of the alveolus, through which the contents of the abscess pass into the substance of the gum. At this stage of the disease we have a kind of double abscess—an abscess with a constriction, one division of which is situated in the gum, and the other within the alveolus, the two being connected by a small opening through the alveolar plate. If the disease be left to run its own course,

(1) An upper jaw in which the effect of alveolar abscess in excavating the bone is shown.

the contents of the abscess will sooner or later find their way to the surface and escape. But the time occupied in the process will depend upon the situation of the disease, upon the condition of the parts prior to the advent of disease, and upon the general condition of the patient. In those who are in strong health, the formation of an alveolar abscess is soon succeeded by swelling of the gum and the escape of the pus. But in patients who are in a debilitated condition the disease advances more slowly; the products of suppuration accumulate, and a large abscess is formed, at the expense, perhaps, of the sockets of several adjoining teeth. Considerable mischief may have been produced before the natural relief by the spontaneous bursting of the abscess is obtained. The pus, instead of escaping into the mouth, may find its way to the surface of the face, or into the antrum. The latter result will of course arise in those cases only in which the disease has originated in the bicuspid or molar teeth of the upper jaw; but there is no tooth from the socket of which an abscess may not extend to the surface of the face. Instances are sometimes met with of an abscess connected with the root of a lower incisor tooth opening under the chin. Others, again, in which collections of matter formed about the wisdom teeth pass between the muscles and bone, and escape at the angle of the jaw.

A collection of pus formed in the socket of an upper incisor, will sometimes burrow along between the bone and periosteum of the hard palate, and open upon the surface of the soft palate; in other cases, the periosteum is separated from the one side of the hard palate, and forced downwards to a level with the crowns of the teeth by the accumulated pus.

The opening of the abscess, whether effected by nature or by the hand of the surgeon, forms an epoch in the complaint. The symptoms from that time gradually subside, the pain dies away, and the swelling rapidly diminishes, leaving a small opening through which pus will continue to be discharged. The coats of the abscess gradually contract, and close upon the root from which they had become separated. The separation of the two parts is, however, permanently maintained. While the inner surface approaches the root of the tooth, the outer surface of the coats of the abscess becomes thickened, and occupies the space which would otherwise be left between the expanded alveolus and the collapsed abscess. In extracting teeth which have been the cause of alveolar abscess, the coats of the abscess are sometimes withdrawn entire, and an opportunity of observing the preceding conditions is afforded.

Such, then, are the events which, in the ordinary course of the disease, mark the progress of alveolar abscess. Exceptional cases now and then occur, in which the local are accompanied by severe constitutional symptoms, amounting perhaps to fever and delirium. Such instances are, however, of comparatively rare occurrence; indeed, it is wonderful how much mischief may be done to the alveolar processes without exciting any great amount of either local or constitutional disturbance. An abscess enclosed in the substance of any other bone, in the manner an alveolar abscess is at its commencement shut up in the jaw, would, instead of producing two or three days of toothache, and a swollen face, confine the patient to his room for weeks.

Alveolar periostitis may, however, move more slowly through-

its various stages. A considerable length of time may intervene between the commencement of inflammatory action and the formation of pus, and in the meanwhile the patient may be the subject of violent intermittent attacks of pain, not, perhaps, confined to the tooth alone, but often extending to the face and head, in which situations the pain may be far more intolerable than in the tooth itself.

In cases answering to the foregoing description, it will frequently be found that dental exostosis, slight in amount, perhaps, yet distinguishable, has commenced on the surface covered by, or in close proximity to, the inflamed tissue.

In other cases, again, the separation of the inflamed tissue is limited to the apex of the fang, through the canal of which the pus oozes; but the relief is then only partial, and the periosteum continues to thicken, and the alveolus to enlarge, to make way for the increase in size of the diseased membrane. The pain is intermittent, and often simulates in its character tic-douloureux. The condition I have described is more frequently found associated with stumps than in teeth the crowns of which are but partially decayed; and it is common to find the extremities of several contiguous stumps similarly involved.

The disease under consideration may assume yet another character: it may begin so gradually, and advance towards suppuration so slowly and painlessly, that the patient is not aware of its existence until he discovers a tumour on the gum, or the contents of an abscess escape into the mouth; so little inconvenience is felt that the occurrence is forgotten, until, from some cause or other, the canal leading to the alveolus containing the remnants of the disease

becomes closed, and pus re-collects. The contents of the abscess again find their way to the surface, and the comfort of the patient is restored. Sooner or later the disease assumes a more active form, and necessitates the removal of the tooth.

Cases of this passive character are sometimes productive of sympathetic pain, and should not, therefore, be lost sight of. The gum, too, over the affected alveolus, frequently becomes thickened, minutely nodulated on the surface, and assumes a mottled hue.

The fistulous opening of a chronic alveolar abscess is sometimes situated on a long papilla-like process, projected out from the gum to the extent of a quarter or even half an inch. It may be flexible, and lie flattened upon the contiguous gum, or the character of a dense hard granulation may be assumed.

In any description of case, should the inflammation be acute in the first instance or subsequently, and the system in an unfavourable state, the diseased action may, and often does, extend to the periosteum of the body of the jaw, and if not speedily subdued, occasion thickening of the bone, or even worse, it may terminate in necrosis of a considerable portion. I have known three-fourths of the under jaw lost from disease commencing in the dental periosteum of one tooth. In more favourable instances, the disease may creep on only to the adjoining teeth, occasion their loss, and then end. In the great majority of cases, however, the inflammation does not spread: the pus makes its way to the surface, and a fistulous opening in the gum, with slight thickening of the surrounding parts, remains to mark the spot.

Several specimens in my own collection show that active

inflammation of the dental periosteum may arise in connexion with a tooth without our being able to trace the cause—that a large alveolar cavity may be formed, the involved tooth and the neighbouring parts being, so far as we can see, healthy. In nineteen cases out of twenty, however, the disease follows or results from, or is an extension of, inflammation of the dental pulp, or is consequent on necrosis of the whole or a part of the fang of a defective tooth.

Treatment.—Local bleeding frequently fails to afford relief in inflammation of the pulp: but when the dental periosteum becomes the seat of disease, the abstraction of blood is our best remedy. If adopted at a sufficiently early stage, it seldom fails to produce relief, and frequently cuts short the disease. One or two leeches should be applied, by the help of a leech-tube, to the gum, opposite the end of the root of the affected tooth, and in connexion with the local bleeding an aperient may be given.

The local remedies for toothache, such as creasote, excepting only sialogogues, are utterly useless in the treatment of alveolar abscess. If the inflammatory action has gone on for a day or two, it is probable that suppuration cannot be avoided, especially if the affection has spread to the gum. In that case, the tooth should be removed, and if there is reason to suspect that pus is lodged in the substance of the gum, the part should be freely incised.

The removal of the involved tooth, however skilfully performed, is not always followed by a cessation of pain; on the contrary, the degree of suffering is sometimes for a while increased, arising, no doubt, from the laceration of the inflamed tissues. The duration of the after pain will generally be pro-

portioned to the extent of the inflammation, and to the amount of sympathetic pain previously excited.

In all cases of pain after the operation of extraction, the sufferer should be directed to hold a strong and hot decoction of poppy-heads in the mouth, and to renew the mouthful when it ceases to feel hot. This application should be continued till the pain abates, an event which, even in the worst cases, may be looked for within an hour or two.

If from any cause the removal of the tooth be inexpedient, we must then do what we can to relieve the pain, and to reduce the disease to a state of passive gumboil. When there is reason to believe that pus has not been formed, a leech may be applied to the gum, and aperients given; but should you find a circumscribed swelling over the tooth, it is pretty certain that pus is making its way outwards, and its progress will be hastened by the use of the gum lancet. When the more active symptoms have subsided, a small fistulous opening will remain for the exit of the pus, unless the fluid finds its way to the surface through the fang. It is quite possible that the coats of an abscess situated in the dilated alveolus may embrace the necrosed extremity of the fang, and cease to secrete; in which case the gum would heal perfectly, leaving the end of the tooth in a similar position to that of an encysted foreign body. But I do not think this event is common, neither would its occurrence be expected, when it is considered that the fangs of teeth admit, under pressure, of a slight degree of motion.

Chronic inflammation of the dental periosteum, limited to the alveolar membrane of one or two teeth, excepting in its extent, and dependence upon a local cause, resembles in

character that form of disease which has been described under the head of general inflammation of the alveolar periosteum.

After a case has passed through its earlier stages, there is some difficulty in determining whether the malady originated in the gum or in the periosteum. At the outset the margin of the gum exhibits increased vascularity, becomes slightly thickened, and bleeds readily. If allowed to run its course uninterruptedly, the inflammation passes from the tissues about the neck of the tooth towards those which surround the root. The tooth becomes loose, the edge of the alveolus disappears, and the gum sinks down. By slow degrees the tooth loses its implantation and falls out. Generally the disease is attended with but little pain, excepting such as is produced by force applied to the loosened tooth.

Tooth after tooth may be, and in old people frequently is, lost, till the mouth becomes edentulous.

The inflammation may, however, take a more active form. We shall then have pus secreted from the surface of the diseased tissue, and granulations may spring up from the margin or from within the socket.

Among the causes which excite chronic inflammation of the dental periosteum may be enumerated, the collection of tartar, a ligature about the neck of a tooth, or pressure applied in an oblique direction by an antagonistic tooth.

The treatment will depend upon the nature of the exciting cause. If a local cause be detected, its removal must be the first step in the treatment; afterwards astringents, such as tannin applied to the gums, will assist in restoring the part to a more healthy condition. In patients of advanced age treatment produces but temporary relief, more especially if the

antagonism of the upper and lower teeth is disturbed by the loss of an important member of either series. But should it be found that an elongated or displaced tooth is unfairly forced upon its antagonist, or upon an adjoining tooth, and is thus inducing disease in the socket of the latter, the offender must be shortened by the file or removed.

In the foregoing section it has been assumed that the inflammatory action has extended over the whole circumference and depth of the socket, and it is not usual to find the disease confined to or more highly developed on a portion only of the root of a sound tooth. But there are many cases to which this rule will not apply.

When a part only of the periosteum is affected, the disease presents a somewhat different aspect; it usually occurs in connexion with a stump; the crown of the tooth having been destroyed by caries. The periosteum about the extremity of the tooth becomes thickened and nodulated; the socket widens as the disease advances, until the neighbouring alveolus is laid open. With this state there is occasional and sometimes severe pain, not necessarily confined to the seat of the disease, often not in the affected alveolus at all, but it is felt in the jaw, or in the cheek-bone, or in the ear. The edge of the alveolus seldom becomes absorbed, so that the fang is held firmly in its place.

When there are three crownless fangs in a row, and the periosteum of one only the subject of chronic inflammation about the end, it is extremely difficult, if not impossible, to detect the offender, unless revealed by tenderness on pressure, or the margin of the gum is encircled with a red line, neither of which symptoms are constant.

This bulbous state of the dental membrane (often termed fungous) is occasionally found in connexion with dental exostosis, and sometimes with necrosis, but in the latter case the disease is disposed to become active, and to end in alveolar-abscess.

There is but one method of treatment—the affected tooth should be removed.

When a patient suffering pain in the jaw, or face, or ear, is unable to state the exact seat of pain, but is disposed to ascribe it to the teeth, it will be well to remove any stumps that are found in the mouth; for the periosteum of one or of all of them may be thickened and diseased, and this will not be known with certainty till they are removed. Very generally the diseased tissue is more firmly connected to the tooth than to the alveolus, and is therefore drawn out with the tooth.

A disease having established itself in the soft tissues subservient to the maintenance of the teeth, the recognition of its origin is at all times attended with difficulty, for no sooner is the periosteum attacked than the contiguous gum becomes affected, and *vice versa*. This remark applies even to tumours arising in this part of the body. A tumour may originate in the gum, or spring from within the socket of a tooth, or it may commence in the periosteum investing the outer surface of the alveoli; but in either case the growth is usually described under the head of tumours of the gums, an arrangement which, for the sake of convenience, will be adhered to in the present instance.

Absorption of the Alveoli.—The gradual wasting of the alveolar processes, accompanied by a corresponding recedence

of the gums, keeps pace with those general changes which attend the advance towards old age. The necks of the teeth become exposed, the gum continues to sink lower and lower till the whole of the roots are uncovered, and the teeth at last fall out. The loss of implantation is not unaccompanied with changes in the teeth themselves. The roots are destitute of cementum, and become translucent, like white horn, and retain that character when perfectly dried, differing in this respect from teeth in a normal state, the roots of which, when deprived of moisture, are perfectly opaque. In the one the opacity is due to the drying up of the dentinal fibrils, and the consequent empty state of the dentinal tubes; in the other, the fibrils are in a more or less perfectly calcified condition, and are incapable of shrinking up when the moisture is withdrawn from the tooth; hence, in the absence of tubular interspaces in the substance of the dentine, its transparency is necessarily preserved. With these concurrent changes, it is difficult to determine which takes precedence, and whether they hold the relation to each other of cause and effect. The evidence is greatly in favour of the assumption that the consolidation of the dentine in the root of the tooth in an aged subject, is the precedent condition lowering the vitality of the tooth, and to a certain extent reducing it to the state of a foreign body, and that the socket and gum are gradually absorbed as a consequence of the ebbing vitality of the part to which they are subservient. This view, I think, holds good when the phenomena are seen in those who have passed the middle period of life, and also in certain other cases; but a question may be raised as to its validity on the ground of want of conformity to those cases in which the crowns of

the teeth are lost, and the roots thereby deprived to a great extent of their life, and yet the absorption of sockets and gums does not follow. I believe, however, the difference of result is due to a variation of the conditions. In cases of absorption of the alvĕoli, the roots of the teeth are almost destitute of cementum, whereas in the roots of teeth around which the sockets and gums are preserved, the cementum is also retained. Examples illustrating this condition will be found in young or middle-aged patients whose teeth have decayed, and broken off close to the edge of the gum, the level of which is for a certain time preserved. Sooner or later, however, the edge of the alveolus recedes, and is followed by the gum.

There are other conditions than those already enumerated under which the teeth may lose their sockets. A case recently came to my notice in which, without any appreciable wasting of the gums, the whole of the upper front teeth became excessively loose and fell out. The alveoli were altogether absorbed, or were greatly enlarged, but the presence of any manifest disease either in the teeth themselves or in the surrounding parts could not be detected. The gums were not more vascular than would be considered consistent with health, and in the teeth there was a total absence of that horn-like appearance previously described; indeed, the cause of the malady was too obscure to admit of recognition.

Absorption of the alveolar processes may be more partial than in the cases previously considered. The outer or the inner plate only may disappear. The accompanying illustration is taken from a preparation in which the labial plate corresponding to the upper front teeth has been removed.

Indications of a similar change in other parts of the jaws

are shown, but the amount of loss is comparatively trifling. The more prominent or out-standing teeth are those the sockets of which are most liable to become absorbed; teeth, the roots of which are but thinly covered by bone and soft parts. This fact is shown in the case figured. The right

Fig. 175. (1)

upper canine has lost the whole of the anterior wall of its socket, while the contiguous lateral incisor, which lies back, has retained the corresponding part of the alveolar investment. The canine teeth being the last of the front teeth to take their position, are subject in a contracted jaw to stand in advance of the dental arch. The course taken by the root can be readily traced, and the small amount of bone and gum

(1) The upper and lower maxillæ, from a subject aged thirty, showing extensive absorption of the alveolar processes of the front teeth.

by which its anterior surface is clothed is recognised. It is from the roots of a tooth so placed that the anterior and projecting wall of the socket most frequently disappears. The labial surface of the root becomes exposed throughout the greater part of its length, leaving the tooth dependent upon the posterior or lingual wall of the socket for its retention in the jaw. A prominent and comparatively unsupported position would seem to offer an explanation of the early disappearance of the outer plate of the alveolus, but cases are now and then seen to which this explanation could not be satisfactorily applied. A specimen in my own collection exhibits the full complement of teeth in the upper jaw, sound and well arranged, but from a bicuspid tooth the whole of the labial plate of the alveolus has been absorbed.

It is in many cases very difficult to discover a satisfactory cause for the premature disappearance of the alveolar processes. The presence of inflammation of the gums, or of the alveolar periosteum, or of collections of tartar about the necks of the teeth, and the consequent irritation of the edges of the gums, are followed as a secondary consequence by absorption; but it is to the occurrence of alveolar absorption, without the precedence or accompaniment of obvious disease in the soft tissues which clothe the socket, that attention has been directed. The frequent use of a hard tooth-brush will hasten the wasting of an out-standing socket, the corresponding gum of which has the appearance of being stretched in a thin layer over the neck of the tooth.

When the alveolar loss is general throughout the mouth, it will on inquiry very commonly be found that a similar misfortune has befallen other and antecedent members of the

family,—that the predisposition to an early failure of the teeth, from the recedence of their sockets, is hereditary.

Treatment.—The dentist is often called upon to prescribe a remedy which, if it will not restore the lost part, will, at all events, arrest the extension of the evil, and in no form of dental malady is he less able to afford assistance. If there be obvious disease in the gums or periosteum, the course of treatment will be clear, and if the teeth be encrusted with tartar, the necessity for its careful and complete removal is apparent. But in the absence of an obvious cause of mischief, we can but direct that the patient should use a soft tooth-brush, employ a moderately astringent dentifrice, take care that the teeth are well cleaned, and, at the same time, avoid irritating the edges of the gums by unnecessary friction.

Fig. 176. (1)

Hypertrophy of the alveolar portions of the jaw, when limited in extent, is far from uncommon. A nodule of bone as large as a pea is often seen projecting from the lingual surface of the lower jaw, and many instances have come under my

(1) The lower jaw of a male subject who died at the age of six years, showing the results of absorption of the alveoli of the temporary teeth. (This figure was accidentally omitted at p. 71, where the upper maxilla from the same subject is inserted.)

notice in which corresponding growths have sprung from the labial surface of the sockets of the molar teeth of the upper maxilla. I remember one case in which a stout bony ridge ran out to the extent of more than half an inch, and then turned upwards. The patient stated that the lodgment of food upon the shelf, as he called it, was the only annoyance to which the exostosis subjected him.

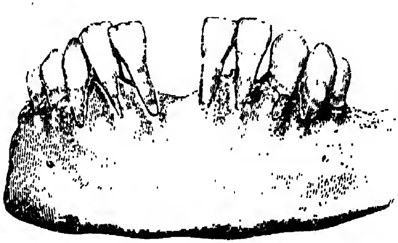
In one case only have I seen hypertrophy of the alveolar processes attended with inconvenience, and for an opportunity of examining the patient I am indebted to Mr. Alfred Canton. The whole of the alveolar bone was greatly enlarged; it projected upwards in the lower and downwards in the upper jaw, carrying before it a red and thickened gum, and concealing within the groove formed by the lingual and labial portions of the alveolar ridge the corresponding surfaces of the whole of the teeth. The thickening in the front part of the mouth was so great that the lips could not be closed. At the back part of the alveolar arch, the thickened and elevated gums of the respective jaws, although mutually flattened, were not sufficiently depressed by the action of the jaws to allow the molar teeth to come in contact. The patient was a half-witted strumous child, whose age did not exceed thirteen years, and whose general appearance justified the assumption that the alveolar disease was but a local manifestation of the presence of a strumous diathesis. The child was taken back to its native village without being subjected to treatment.

There is another form of abnormal development of bone in the alveolar portion of the jaw worthy of attention, inasmuch as it is productive of great inconvenience to the patient.

After the luxation of a tooth, the socket in young and middle-aged subjects is to a certain extent filled up from the bottom by the development of bone. This process, which, after the loss of a tooth is reparative, becomes destructive when the action is set up in the socket of a sound tooth. The tooth by slow degrees becomes longer than its neighbours, and after the lapse of a considerable length of time, loosens and falls out, or is removed in consequence of its inconvenient length.

In other cases, again, the teeth, without being extruded by the development of bone within their sockets, are separated from each other by the thickening of the intervening bone. In some cases the shifting of position may be due to derangement of the normal antagonism of the upper and

Fig. 177. (1)



lower teeth; but there are others in which this cause will fail to explain the gradual separation of teeth which are apparently sound and healthy.

Treatment.—Exostosis, if it can be traced to irritation pro-

(1) Shows the front teeth in the lower jaw separated from each other in the median line by the thickening of the intervening bone, independent of the presence of disease. (From Mr. Saunders's collection.)

duced by the presence of a diseased tooth, will probably be arrested by the removal of the offending organ; but when the abnormal growth is attributable to any other causes, or arises independent of any cause which we can discover, treatment otherwise than by excision will be attended with but questionable advantage. The size attained by an alveolar exostosis is not usually sufficient to produce an amount of inconvenience that would incline the patient to submit to, or the dental surgeon to propose, its excision.

Necrosis of the Alveolar Processes.—The death and ultimate separation of a large portion of the body of the lower jaw including the alveolar margin and the contained teeth, occurs in children of strumous diathesis, and the disease may be, and I think commonly is, set up by a decayed tooth. The pulp of the tooth inflames, the inflammation extends to the periosteal lining of the socket, and from thence spreads to the body of the jaw.

Cases, however, of this description belong rather to the general than to the dental surgeon. To the surgeon their treatment is usually entrusted, and to the works on general surgery the reader must be referred for an account of necrosis of the maxillæ.

Necrosis of a portion of the alveolar division of the jaw is of comparatively common occurrence, and frequently comes under the care of the dental surgeon.

The death of the bone is consequent upon inflammation of the periosteum lighted up by disease established in a contiguous decayed tooth, or by ulceration of the superjacent gums; by mechanical injuries of the jaw; or by the unskilful extraction of teeth, and, by that operation even when skilfully per-

formed, in persons who are in an unfavourable state of health. The disease may arise at any period of life, but it occurs more frequently in children than in adults; and in the former it is, I think, more commonly seen in the lower than in the upper jaw.

In children the sequestrum is generally limited to the sockets of one or two temporary and the crypts containing the succeeding permanent teeth; and the situation in which the disease most frequently establishes itself is that occupied by the temporary molars. To this rule many exceptions will be found. The dead bone may be cast off, and leave the forming permanent tooth or teeth behind, injured, perhaps, but not destroyed.

Necrosis, when it occurs in adults, may fall upon any part of the alveolar arch, and may arise at any period of life. I have seen cases in young, middle-aged, and in quite old people.

The indications which attend necrosis are at the outset undistinguishable from inflammation of the alveolar periosteum, but they differ as the disease advances. Instead of the formation of a local and circumscribed swelling, the gum over the diseased bone becomes generally thickened, tumid, and of a deep red colour; pus oozes up from the edge of the gum. After a time the gum separates from the alveolus, the margin of which becomes exposed. The involved tooth or teeth loosen and fall out. In the course of a few weeks the dead alveoli are detached from the subjacent living bone, and lie loose in the substance of the thickened gum, bathed in pus.

Treatment.—There need be no hesitation in removing a

tooth which has caused the disease, but the propriety of at once extracting sound teeth which have become implicated by the extension of the disease may be questioned.

Instances have been recorded of teeth, loosened and apparently in a hopeless condition, having, after the removal of the sequestrum, become firmly fixed, either in the remaining portion of the bone or in alveoli subsequently developed. Before the dead is separated from the living bone a layer of the latter must be absorbed, a process which has already been described in connexion with the shedding of the temporary teeth. The separation of the sequestrum must be left to nature. We can render no direct assistance; but it must be the business of the practitioner to see that nature has a fair chance, by attending to the general health of the patient, removing any obvious source of local irritation, and keeping the diseased part in a cleanly state. In effecting the latter purpose, a wash, composed of five grains of chloride of zinc to an ounce of distilled water may be used. It will excite healthy action, and greatly diminish, if not entirely overcome, the fœtid smell which attends suppuration associated with dead bone.

If, after the sequestrum has been separated from the body of the jaw, it is entangled in the soft parts, the scalpel must be used to effect its liberation. With the removal of the dead bone the treatment of the case may be said to terminate. The inflammative action in the gums and contiguous structures, in the absence of a source of irritation, rapidly subsides, and the mouth is speedily restored to a state of health.

DISEASES OF THE GUMS.

Acute inflammation of the gums.—Active inflammation, when situated in the gums, rapidly involves the adjacent periosteum both of the external and internal surfaces of the alveoli, and by thus extending, tends to mask the original character of the disease, the nature of which, if the case be not seen in an early stage, may be involved in considerable obscurity. The malady, however, extends in another direction, and by so extending its nature becomes declared. The inflammation, at first limited to the mucous membrane of the gums, spreads to that of the mouth. The salivary glands become affected, and pour out an excessive amount of secretion, the flow of which becomes a conspicuous feature in the disorder. When this takes place, the patient is said to be salivated. Although cases of spontaneous salivation are recorded, well marked examples are rarely met with. As the result of remedies administered for the cure of disease its occurrence is common, but not so common as in former years, when mercury was more frequently used, and its effects were further pressed. In cases of inflammation of the gums so induced, an opportunity of watching the disease from its commencement is afforded.

In salivation produced by mercury, the effect is first discernible upon the gums. Some hours previous to the occurrence of the metallic taste, and to the fœtor of the breath, and also to the soreness and discomfort of the mouth which mark the influence of mercury on the system, the gums show indications that these conditions are about to appear — that the patient will in a few hours be salivated. The state

of gum I am about to describe is, in fact, a premonitory sign of ptyalism, for should it appear, and the mercury be immediately discontinued, yet salivation will come on. The sign is this:—the adherent portion of the mucous membrane of the gums assumes an opaque white colour, contrasting strongly with the non-adherent portion, which preserves its natural hue or becomes more red. The free edge of the gums is moveable, but that part which lies over the edge of the alveoli is firmly tied down to the periosteum; and as the edges of the alveoli present a festooned line, so the whitened mucous membrane presents corresponding undulations. Again, where the mucous membrane is loosely reflected from the gum to the cheek, the natural colour is preserved. The whiteness of gum is produced by an increased secretion of epithelium, which, from being thicker and more opaque than in the healthy state, renders the colour given by the vessels to the subjacent tissue less apparent.

The surface of the mucous membrane, when deprived of epithelium, is studded over with innumerable small conical elevations, or papillæ. The thickened epithelium is readily rubbed off the tops of the papillæ, while it retains its full thickness in the intervening depressions; hence, if closely inspected, the gums will not be seen to present a uniform white hue, but a mottled aspect.

With the increased thickness there is a decrease of tenacity between the scales that form the epithelium, for the surface may be much more readily rubbed off than when in its natural state.

This curious and useful premonitory sign of coming ptyalism was, I believe, first noticed, and its value pointed out,

by Mr. Corfe; at all events, he first of all drew my attention to the fact, and I am not aware that it had been previously described. Since, however, Mr. Corfe mentioned the result of his observations as to the constancy of the sign, I have verified for myself its presence in all cases of salivation that have come under my notice, and from these the foregoing account has been given.

Dr. West, in treating upon inflammation of the mouth (stomatitis), says: "Inflammation of the mouth is an occurrence by no means confined to the period of teething, but it comes on in children of all ages, assumes very different forms, and leads to very different results in one case from those which characterize it in another. The mucous follicles of the mouth are the chief seat of the disease in one case, the substance of the gum in another, and that of the cheek in a third. In the first (follicular or aphthous stomatitis), the affection issues in the formation of several small ulcers, which heal eventually of their own accord; in the second (ulcerative stomatitis), an unhealthy process of ulceration destroys the gums and denudes the teeth, but it is tardy in its advance, and tends to a spontaneous cure; while in the last, mortification (gangrenous stomatitis) involves all the tissues of the cheek, and spreads with a rapidity which remedies fail to check, and which is arrested at last only by the patient's death."(1) Although each of the foregoing forms of disease have a constitutional origin, and for the most part fall under the treatment of the surgeon, yet they sometimes come under the notice of the dentist.

(1) Lectures on the Diseases of Infancy and Childhood. By Charles West, M.D. Third edition.

Follicular stomatitis is commonly associated with eruptions about the face and lips, and may fairly be referred to the general practitioner; and should that rare but fatal disease, gangrenous stomatitis, be met with, further aid should at once be sought.

Ulcerative stomatitis is a form of disease for the relief of which the assistance of the dental surgeon is not uncommonly sought, and it is to the description of this malady that the following remarks will be limited.

The free edge of the gums is the point at which the disease first shows itself. This part becomes congested, thickened, assumes a deep purple colour, and bleeds from the slightest touch. To the occurrence of these conditions, ulceration very quickly succeeds, and it is then that the nature of the ailment is pronounced. The ulcer is marked by the following characters :—The surface is covered over by a yellow or grey secretion, which on removal by a current of tepid water, leaves exposed numerous red points scattered over a yellow ground. These points correspond to imperfect granulations, and the yellow ground to decomposing gums. The repeated application of a jet of water will carry away a further quantity of the secretion, but it will fail to remove the shreds of dead tissue which lie between the less prominent parts of the ulcer.

The ulceration, commencing on the edge, extends into the substance of the gums, laying bare the necks of the teeth, and even the alveolar processes. The mucous membrane of the cheek, where it lies in contact with ulcers upon the gums, becomes in some cases similarly diseased. The malady commonly shows itself in the first instance in the

front part of the mouth, extending in severe cases to the gums about the molar teeth. The lower gum is more frequently attacked than the upper, and the labial surface more frequently than the lingual surface of the gums.

Although adults are not wholly exempt from attacks of ulcerative stomatitis, the disease occurs very much more frequently in children. The cases which have come under my own notice have occurred in young people living in crowded localities, and who have been imperfectly clothed and fed. According to Dr. West, however, "it is by no means a constant occurrence for any special derangement of the general health to precede an attack of ulcerative stomatitis, though the children who are affected by it are seldom robust, and in many instances are such as have suffered from deficient food, or a damp and unhealthy lodging, or both." In young children who are but indifferently cared for, the disease in its earlier stages is overlooked, until the suspicion of the attendant is aroused by the fœtid state of the breath, the dribbling of the saliva, and the unwillingness of the child to take into the mouth food or anything that is calculated to produce pain in the ulcerated surface. When the disease is unchecked by treatment, it may lay bare a large portion of the alveoli of several teeth, which, with their sockets, become dead and blackened, and these serve to keep up the malady.

The treatment of ulcerative stomatitis is usually attended with well-marked success. Local treatment is by Dr. West regarded as of secondary importance, and might, he says, in many cases be omitted without prejudice to the patient. He says, "Lotions of alum, or the burnt alum applied in substance, or the chloride of lime in powder, have all been used locally,

with more or less benefit. It was my custom also to prescribe these remedies in ulcerative stomatitis; but since I became acquainted with the virtues of chlorate of potash, I have learned to rely upon it almost exclusively. It appears, indeed, almost to deserve the name of a specific in this affection, for a marked improvement seldom fails to be observed in the patient's condition after it has been administered for two or three days; and in a week or ten days the cure is generally completed. Three grains every four hours, dissolved in water, and sweetened, is a sufficient dose for a child three years old; and five grains is the largest quantity that I have administered to a child eight or nine years old." The general health of the patient must at the same time be watched, and a purgative administered if the bowels require relief. Nutritious food should be given, and in the feeble subjects quinine or other tonics prescribed. In the cases which have come under my own treatment, the administration of these remedies has been followed by the rapid recovery of the patient.

The application of nitrate of silver to the surface of the ulcer at once changes its character, by forming a superficial slough, after the separation of which a healthy granulating surface is left. The excessive tenderness, too, is almost instantaneously relieved. The use of a wash composed of five or six grains of chlorate of soda to one ounce of water, will suppress the offensive odour. Teeth which are hopelessly loose, and productive of irritation, should be removed.

There is another form of ulcer which usually attacks the gums at their junction with the free mucous membrane of the mouth, or the mucous membrane itself, at all periods of life

equally. The ulcer is usually of small size, circular, excavated, and yellow in colour. Though insignificant in extent and duration, it is extremely sensitive and troublesome while it lasts, rendering the movements of the tongue and the act of mastication painful. Excepting that this disease is as common at one age as at another, and that it is unusual to find more than one ulcer at a time, the malady may be described as follicular stomatitis.

Treatment.—If the surface of the ulcer be touched with nitric acid, applied with a camel's-hair pencil, the tenderness of the surface will cease, and the patient will probably suffer no further inconvenience. The cure may be said to be instantaneous. Of course it is necessary to prevent the acid from extending beyond the limits of the ulcer.

Chronic inflammation of the gums.—This form of disease is very common in the middle and later periods of life, and when once established is apt to prove obstinate.

The surface of the gums becomes minutely nodulated, and the secretion of epithelium increased; the papillæ are abnormally prominent, while the substance of the gums, including the terminal margins, is generally thickened and indurated. The disease may be confined to the vicinity of one or two teeth, or it may extend over the whole mouth; the extent depending upon whether the cause be local or general.

The pain attendant upon this malady is inconstant, both in degree and in character. In some cases but little uneasiness is complained of, unless when eating, while in others the patient is seldom free from pain. Then, again, in others it comes and goes irregularly, or sometimes regularly; an

attack of pain may set in every evening about bed-time, and the suffering may be continued for several hours.

If the disease be allowed to pursue uninterruptedly its own course, one of two results may be looked for. The alveoli will be wasted away by absorption, or an opposite effect will be produced. The alveolar processes will be increased in thickness by the addition of porous bone to their outer surfaces, and more especially to the marginal portions. In the former case, the teeth are lost by the removal of their sockets; in the latter, by the extension of the disease to the alveolar periosteum.

Chronic inflammation of the gums is very commonly the result of indigestion, when general; but when limited to part of the mouth, it usually follows pre-existing disease of the dental periosteum produced by stumps or faulty teeth.

Treatment.—The cause of the disease, whether local or general, should, if possible, be removed. Considerable advantage will be gained by local treatment. The gums may be lightly scarified with a sharp lancet. This may be succeeded by the local application of an astringent, and I know of nothing more effective than tannin. It may be used in solution, but the powder itself, in a finely divided state, if rubbed over the surface of the gums, will be found to produce a more decided, and I think lasting, effect than astringent washes. Compound spirits of horse-radish, or spirits of scurvy-grass, will be found useful adjuncts in chronic and obstinate cases. Teeth which have become loose by their movement in the gums tend to keep up irritation, and should therefore be removed.

There is a singular modification of chronic inflammation of

the gums, in which, instead of becoming thickened and irregular on the surface, they seem rather to decrease in size, assume a very smooth and polished surface and mottled aspect; at the same time the disease may extend over the surface of the hard palate. The malady is attended with acute intermittent pain, which may be confined to one side of the mouth, or even to half of the upper jaw; it very commonly comes on in the evening, and keeps the patient awake half the night. The patients suffering from this complaint who have come under my notice have been, for the most part, poor middle-aged females, in whom menstruation was becoming irregular, or had altogether ceased; and they have always been cured by the use of a mild aperient—such as sulphate and carbonate of magnesia, given in small doses twice a day. Under this treatment the pain in the gums will probably cease within a week or nine days, and their restoration to a healthy condition will speedily follow.

Chronic inflammation of the gums may assume characters altogether different from those which have been described. Instead of presenting thickening and induration, the tissues may be loose, spongy, and highly vascular, bleeding freely on the slightest touch, and very tender; the gums rise up and cover over a considerable portion of the crowns of the teeth. The papillæ which stud over their surface, become greatly enlarged, and the vessels which, in their looping and inosculations, form so interesting an object when subjected to microscopic examination, become, if not more numerous, greatly lengthened and dilated. I am indebted to Mr. Roberts for the use of a beautifully injected preparation of an inflamed, and as it would be called, scurvied gum. It is not from the human subject.

After injecting a monkey, he found that the vessels of the thickened and inflamed gums had received the injection. From the preparation so obtained the following illustration is taken.

Fig. 178. (1)

The condition which has been described may arise in connexion with, and as a consequence of, diseased teeth; the causes and the complaint itself being in that case strictly local. But in certain states of the system attended with an altered condition of the circulating fluid—in blood diseases, as they are often called—the whole of the gums become similarly affected, and in maladies partaking of the nature of sea scurvy and purpura, this peculiar condition of the vascular tissues about the teeth forms a characteristic feature.

When this disease has a constitutional origin, the treatment of the gums is altogether secondary to the treatment of the disease, of which the condition of the mouth is but one symptom. For an account of such complaints, reference must be made

(1) Shows the injected vessels of gums inflamed and sufficiently enlarged to cover over and obscure the greater portion of the labial surface of the incisor teeth. The preparation was obtained from the mouth of a deceased monkey, by Dr. Roberts, to whom I am indebted for the illustration.

to the works which treat of scurvy and purpura. With the subsidence of the general symptoms, the condition of the mouth will gradually improve, and then some assistance may be given by the use of astringent and stimulating applications. Tannin, solution of myrrh, and borax dissolved in spirits of wine, compound spirits of horse-radish, may each in turn be used. If an offensive discharge escapes from the gums, rinsing the mouth from time to time with a weak solution of chloride of zinc will not only overcome the fœtor, but will also stimulate the secreting surfaces to a more healthy action. When the disposition to active bleeding has subsided, the removal of loose stumps or diseased teeth if sources of local irritation, will be attended with advantage.

TUMOURS OF THE GUMS.

Tumours of several kinds are occasionally found springing either from the substance of the gums or the subjacent periosteum, or the alveolar bone. Simple hypertrophy of the gum itself, or polypus, epulis, and vascular tumours, constitute the principal varieties.

Polypus or fungus of the gum.—It is not uncommon to find a cavity situated on the mesial or distal surface of a tooth filled up by a vascular mass, similar in colour and general character to the contiguous gums. It may be an outgrowth from the dental pulp; more commonly, however, it springs from the inter-dental gum. On a close examination it will be found that the tooth has decayed down to the level, or even below the edge of the gum, leaving a sharp ragged margin, capable of acting as a source of irritation; that the gum

has grown up from a flattened pedicle, expanded, and filled up the cavity in the tooth; in other words, that a tumour has been produced by local irritation. The structure of these growths is similar to that of the gum from which they spring. They are for the most part composed of fibrous tissue, covered by a layer of mucous membrane. The occurrence of pain is not a necessary consequence, although frequently associated with this disorder. Tumours so situated are very liable to be forced against, and injured by, the ragged edge of the tooth which has led to their growth; and the injured part may become painful, more especially if the wound ulcerates. The patient is unable to distinguish the pain so produced from that which arises from inflammation of the dental pulp.

If allowed to take its own course, the new growth usually rises to the level of the masticating surface of the adjoining teeth, and its further increase is restrained by the action of the opposing tooth. It will spring up again and again after simple excision, but if the decayed tooth be removed, or reduced to the level of the gum, any subsequent development of the mass is not only checked, but that which has been already produced rapidly wastes away, and is lost.

In the treatment of cavities situated on the mesial or distal surfaces of teeth, it is frequently necessary to cut away the sides of one or more teeth down to the level of the gum, leaving a wedge-shaped interval. Into the space so produced the gum will sometimes advance, and is then liable to be injured by food, which, in the course of mastication, becomes forced into the separation between the teeth. The pain attendant upon this condition is usually attributed to the teeth which have been operated upon, and may very

readily be mistaken for ordinary tooth-ache. The absence of a cavity within which the new growth can find partial protection from pressure, appears to limit its growth, for in these wedge-shaped intervals we seldom find that it attains a size beyond that of a slight excrescence. This circumstance may be taken advantage of in our treatment of the disease.

Treatment.—Decayed teeth, when they afford a receptacle for polypus, are usually too deeply involved in disease to admit of successful treatment. It is better that they should be extracted, an operation which not only removes a useless organ, but cures at the same time the disease of the gum.

When the gum between two teeth which have been successfully filled, becomes diseased, a different course must be adopted. The roots of contiguous teeth usually diverge in their passage into the jaw, and a second divergence is produced by cutting away the sides of the crown. This leaves a constriction at the point where the excision of the tooth or teeth terminates. It is when the gum rises above this part that it becomes troublesome. Our aim must be to reduce the gum by pressure, or by the use of an escharotic, to its normal position—to a level with the constriction formed in the manner described, or even a little below it. The mere reduction of the gum to its normal limits will not of itself be sufficient to effect a cure; the pressure must be continued until the disposition to advance is overcome. I should think the electric cautery would be useful in accomplishing the first part of the operation. In my own practice I have used sulphate of copper, or have had recourse to pressure only. The introduction of cotton wool, saturated with a solution

of mastic, and renewed from time to time, has answered the purpose tolerably well. After the gum has been pressed down sufficiently, a little gutta percha may be introduced between the teeth, and allowed to remain for ten days or a fortnight. Before, however, this treatment is adopted, the operator must satisfy himself that the irritation of the gum is not consequent upon the presence of a rough edge, projecting either from the faulty tooth or from the plug, or even from a piece of adherent tartar.

Tumours springing up from the margin of the gums, whatever may be their structural character, usually receive the designation, epulis.

The disease at its onset is usually confined to the edge of gum, and very commonly to that portion which lies between two teeth, which, with the growth of the tumour, become gradually separated. The separation does not, however, afford sufficient space for the accommodation of the new structure, which by slow degrees spreads itself out either upon the labial or lingual surface of the gums, or upon both. The attachment, at first limited to the inter-dental portion of the gum, may not spread with the increasing size of the tumour, or the base may be gradually extended over the alveolar bone. In other words, the epulis may be attached by a small and flattened pedicle, or by a broad base. The submucous fibrous tissue, or the soft tissue contained in the Haversian canals of the bone, usually afford the site of the disease, which in its growth carries before it the superjacent mucous membrane. The tumours springing from the fibrous tissue are very generally themselves fibrous in character, and, lying close to the surface of the bone, very frequently contain

osseous spicula. The new bone may be altogether detached from, or it may shoot out of, the alveolar process, the surface of which, in either case, is usually abnormally rough. In respect to vascularity, an epulis commonly does not much exceed that which prevails in the adjacent gum, and the density of the tumour usually corresponds with that of the latter structure.

When the new growth has attained a considerable size, secondary conditions are induced, which complicate, and to some extent alter, the character of the disease. Unrestrained by surgical treatment the tumour, at first small, and productive of but little inconvenience, increases in size, generally encroaches upon the space assigned to the tongue, or upon the hard palate, and covering over one or two of the teeth, impedes both mastication and articulation. The surface becomes injured either by the teeth of the opposing jaw, or by those whose crowns it has overrun. The injured part becomes the site of an ulcer, which emits a copious and fœtid discharge; and the patient, in the place of feeling inconvenience only, is submitted, if not to acute suffering, to great annoyance. The external characters of the ulcers sometimes closely resemble those assumed by malignant disease, and may present the further likeness in the occurrence of hæmorrhage; but the cases in which epulis passes into cancer very rarely occur.

Such, then, are the general characters of epulis. As regards the structure of these tumours, three varieties may be noted: first, those which are composed of fibrous tissue intermixed with fibro-plastic cells; secondly, those which are mainly composed of the elastic fibrous tissue, the individual

fibres of which, like those of yellow elastic tissue, are tolerably uniform in size, curl up when divided, and remain uninfluenced by the action of acetic acid; thirdly, those composed of myeloid cells. The two preceding forms have come under my own notice; the latter has been described and figured by Mr. Hutchinson, (1) who gave the following description:—"On examination, the epulis presented all the characters of myeloid growth in a most remarkable degree. Its section was very vascular, and showed hues varying from a deep red to buff, and a peculiar light-greenish tint of yellow (xanthoid of Lebert). Scattered in its structures were some detached masses of soft, spongy bone. Under the microscope were seen abundance of the large poly-nucleated bodies characteristic of these growths, many of them being very irregular in shape, and much branched."

In many cases it may be extremely difficult, if not impossible, to discover any satisfactory cause for the occurrence of epulis; but in others an examination of the tumours reveals a source of irritation to which the presence of the disease may with probable truth be assigned. In a case of epulis treated by Mr. De Morgan, the tumour contained an isolated piece of bone, which, on careful examination, was found to be embedded and entangled in, rather than adherent to, the fibrous tissue which composed the mass. After it had been dislodged from the tumour, and submitted to microscopic examination, the following characters were clearly manifested:—The whole of the surface bore the marks of absorption, while the substance of the bone presented the structural characters of normally developed tissue.

(1) Transactions of the Pathological Society, vol. viii. page 380.

The presence of these characters, and the size of the fragment of bone, fully justified the assumption that it at one time formed a portion of the subjacent alveolus, and that its detachment had been effected by absorption; and further, that when so detached, it had proved a source of irritation, and thus led to the development of the epulis. In a case previously published, the stump of a tooth, the crown of which had been broken off five years before, was found in the centre of an epulis. (1)

The disease is comparatively rare, and the examination of the bone which is very commonly found imbedded in the tumour, may not have been conducted with reference to its structure, condition, and external characters. In the absence of such examination, it is quite possible that the cause of the morbid growth may have been in many instances overlooked.

Treatment.—Complete excision of the tumour is the only remedy upon which dependence can be placed; and supposing spicula of bone to have shot up from the alveolar process, the surface of the bone must be cut away, or freely treated with an escharotic. When the disease has grown up between two sound teeth, it may be necessary to extract one or other, in order to enable the operator to remove the whole of the tumour.

Vascular tumours of the gums.—The gums are sometimes the seat of tumours which, but for their close structural resemblance to nævus, might come under the head of epulis. The disease first shows itself in a bright red pimple, slightly raised from the surface of the gum; and in the cases which have

(1) Lectures on Dental Physiology and Surgery.

come under my own observation, the growth has been situated between the front teeth. The size is gradually increased, the teeth become separated, and the tumour extends upon the gum both in front and behind the teeth. It bleeds freely when rubbed by the tooth-brush, is soft and compressible, and may be reduced to the colour and level of the gum by steady and gentle compression.

I have not seen more than three or four examples of this form of disease, and each was treated successfully by the frequent application of powdered tannin to the surface of the tumour.

Hæmorrhage from the alveoli.—Prolonged bleeding from the gums has been alluded to in connexion with diseases of that portion of the dental system. It is hæmorrhage occurring after the extraction of teeth which has yet to be described. Ordinarily blood ceases to escape from the socket within half an hour of the removal of the tooth; but isolated instances, in which the bleeding has ceased only with the life of the patient, have been at long intervals recorded; and cases in which the flow of blood has been checked with considerable difficulty, and only after the patient has been greatly reduced, though not common, are by no means rare.

Before proceeding further in the description, it may be useful to inquire under what condition these untoward consequences follow upon a very simple and, under ordinary circumstances, a very safe operation.

When from an insignificant wound the blood flows for a longer time and in a larger stream than the nature of the injury would lead the surgeon to expect, a state of system is denoted which may be a permanent cha-

racter peculiar to the individual, or it may arise from a temporary condition of the circulating fluids, or from the condition of the blood-vessels themselves. There are those who have at all times difficulty in arresting bleeding even from a slight wound, and in them prolonged hæmorrhage usually follows the extraction of a tooth. A patient of my own suffered considerable inconvenience from a very loose lower bicuspid tooth, but dreaded its removal, in consequence of the difficulty he suffered in controlling the hæmorrhage which had on previous occasions followed the extraction of teeth. The loose bicuspid was, however, removed, and the blood ceased to flow from the socket within half an hour. The patient returned home, but before he had reached the end of a short railway journey, bleeding from the socket had recommenced, and many hours elapsed before the hæmorrhage was perfectly arrested. The hæmorrhagic diathesis was in this case fully pronounced, and was independent of the general health. The condition of the vessels or of the blood must have been different from that which usually exists in a perfectly healthy individual, but the difference was not sufficient to interfere with the general health of the patient.

In some persons the disposition to profuse bleeding occurs only at a comparatively advanced period of life; the fault then lies in the vessels themselves, the coats of which become stiffened by the presence of a deposit within their substance, and they consequently lose the power of contraction. In other examples the hæmorrhagic tendency depends upon an abnormal state of the blood—upon the presence of blood disease, as certain maladies are called.

Sea scurvy and purpura afford the most striking examples

of such diseases, one peculiar feature of which is the loss of coagulating power in the blood.

In a healthy subject the division of bloodvessels of moderate size is followed by contraction of their divided ends, and by the coagulation of the blood upon the surface of the wound. By the concurrence of these changes, the escape of blood is arrested. But when the vessels have lost the normal power of contraction, or the blood its capability of coagulation, the bleeding, even from the removal of a tooth, may seriously endanger the life of the patient.

In patients of hæmorrhagic diathesis, the extraction of teeth, and indeed other operations which involve the injury of soft parts, should be avoided, unless the circumstances of the case render them absolutely necessary. But in the practice of dental surgery the existence of this state of system sometimes is learnt only by the occurrence of prolonged bleeding from the alveolus, or from the statement of the patient after the tooth has been extracted.

Treatment.—In the cases of alveolar hæmorrhage which have come under my own care, the bleeding has been speedily arrested by matico. After clearing away the coagulated blood, a leaf of that plant, previously softened with hot water and rolled up, has been placed loosely within or fitted closely into the socket. A few folds of lint laid upon the gum, and held in position by closing the mouth, has been sufficient to retain the matico in the alveolus until the bleeding entirely ceased. On examining the mouth on the following day, I have often found the leaf held in the socket by the blood which had coagulated about its surface and within its folds. If the simple treatment with matico proves unsuccessful, pressure, by means of a care-

fully constructed plug, should be tried. The socket having been cleared of blood, a little matico may be introduced, and then small pieces of lint added and carefully packed one after another, so as to completely fill the alveolus. Upon the surface of the gum, folds of lint should be placed in sufficient number to allow the teeth of the opposite jaw, or the jaw itself in the absence of teeth, on closing the mouth, to produce firm pressure upon the surface of the bleeding socket. To keep up the pressure, the volition of the patient should not be trusted. It will be better to pass a bandage under the jaw and over the head sufficiently tight to prevent the mouth from being opened. The use of escharotics in the treatment of hæmorrhage is attended with this great disadvantage. The parts with which they come in contact are destroyed, and as their action cannot be limited to the interior of the bleeding alveolus, the surface of the wound may become extended, and should the caustic fail to produce the contemplated effect, the difficulties of treatment are enhanced by the increased size of the bleeding surface.

In the case of a child who suffered from hæmorrhage after the extraction of a temporary molar in the lower jaw, lunar caustic, and afterwards spirits of turpentine, were applied without success. At the time I saw the patient, blood was oozing both from the alveolus and the surrounding gum, the surface of which had been made raw by the caustic. This case yielded to the matico leaf carefully applied in the manner already described.

In more obstinate cases it may be necessary to have recourse to a mechanical apparatus for producing pressure. Dr. Roberts and Dr. Reid of Edinburgh have each described instruments for effecting compression. The pressure is ob-

tained by a moveable bar suitably bent. It is supported upon a frame which is fixed to the lower jaw, or to the head, as the seat of hæmorrhage may be in the upper or lower jaw. By these mechanical appliances the pressure may be graduated and maintained without taxing the efforts of the patient.

In the absence of such an apparatus, a plate in metal might in the course of an hour or two be struck to fit the surface of the gum, or a piece of shel-lac moulded to the required form. The plate should of course extend beyond the bleeding surface, and fit closely to the surrounding mucous membrane, upon which it must be firmly pressed by means of pledgets of lint retained in position by pressure.

Mechanical Injuries of the Teeth—Abrasion.—When from the loss of teeth the process of mastication falls upon a reduced number, considerable injury may arise from the wearing down of their crowns, more especially if the antagonism of the upper and lower series be deranged. The crown of a tooth may be cut down, excepting at one side, where a sharp edge of enamel may be left standing, or a lower tooth may strike obliquely upon its antagonist, and gradually cut away its side, even to the extent of perforating the wall of the pulp cavity.

A sharp and ragged edge of enamel, projecting above the general level of a tooth, should be carefully reduced with a fine file; for apart from the injury that may be inflicted upon the tongue or the lips, the tooth itself may eventually be injured. Sooner or later the projecting part will be broken off, and very likely carry with it a considerable portion of the tooth. In the front teeth, this accident is very liable to arise if a thin and ragged edge of enamel is allowed to remain.

After the file has been used, the surface should be rendered perfectly smooth by a slip of Arkansas or other suitable stone.

Fig. 179. (1)

Another form of *abrasion* is that which is occasioned by the action of the tooth-brush on the necks of the teeth, or upon such parts as are but indifferently protected by the enamel or by the gum. The teeth become very gradually indented by highly-polished transverse grooves.

The occurrence of such grooves has been, by many writers, supposed to be independent of a mechanical cause. They have attributed the loss of substance to erosion, using the term as expressive of a sort of ulceration, much in the same sense as it is employed in "erosive ulceration."

In the many cases which have come under my own notice, I do not think that a single example has presented itself in which the grooving could not be attributed to the action of the tooth-brush or to mechanical action in some other form. The more prominent teeth are almost invariably the most deeply cut, or teeth in which the enamel is obviously defective. Again, in a right-handed person the teeth on the left side of the mouth suffer more than those on the right side, and in left-handed people the

(1) An instrument for holding a small piece of Arkansas or other stone, used in rendering smooth the surface of teeth which have been filed, or for rubbing down the surface of a gold plug preparatory to burnishing.

converse holds good. The occurrence is limited to the labial surface, and to such parts of that surface as are exposed to the action of the brush. If the injury were effected by any peculiar and unknown process of ulceration or of absorption, we should surely find evidences of its occurrence under circumstances that would preclude the possibility of a strictly mechanical origin.

Treatment.—A groove having been produced, we can but direct the patient to avoid those causes which have been instrumental in its production. But in guarding against the extension of the mischief, we must be careful to caution the patient against running into a still greater evil. The use of hard brushes and gritty tooth-powder should be avoided. The teeth must however be properly cleaned, otherwise the polished surface of the indentation will be lost, the exposed dentine will be acted upon by the fluid of the mouth, and caries will be established.

Fracture of the Teeth.—The teeth, from their exposed position, and from the office they are destined to fulfil, are liable to be broken. The amount of injury will vary from the slight chipping of the edge to the fracture through the pulp-cavity, or through any portion of the root.

When the loss is trifling in amount and does not materially interfere with the personal appearance of the patient, nothing further than the removal of any sharp or projecting edge, by the use of the file or strip of stone, need be attempted. But should the fracture extend into or even to within a very short distance of the pulp-cavity, a more decided course of treatment will be called for. The nature of that treatment will be determined by the direction the fracture has taken,

by the amount of injury the root of the tooth sustained at the time the accident occurred, and by the age of the patient.

The incisors from their exposed position are more frequently fractured than the bicuspid or molar teeth. The latter are not, however, exempt from accidents. When the jaws are violently driven together by a blow or a fall, and sometimes even in the effort of mastication, a back tooth will give way. A cusp may break off, or the fracture may extend through the pulp-cavity, and detach one or other of the roots, with its corresponding portion of crown. I have seen in a bicuspid tooth the fissure extend from the crown through a greater portion of the root.

It may be stated generally, that when the fracture extends through the pulp-cavity in the direction of the gum, the root also will be injured, and that the tooth should at once be extracted; and the rule will apply when an opening is made into the pulp-cavity of a tooth, the root of which is incompletely formed, whatever may be the direction or the extent of the fracture. If, on the other hand, the crown of a tooth be broken off transversely external to the edge of the gum, there is a fair chance of preserving the implanted portion, and of rendering it subservient to the support of a new crown by the operation of pivoting, or grafting as it is sometimes called, should such a course seem desirable.

It is, however, only in teeth with single roots that the operation can be performed with success. Even in the bicuspids of the upper jaw, and more especially in the first bicuspid, the application of a pivot is not always admissible. The roots of these teeth are not only subject to great lateral compression, but to actual division into two or into three dis-

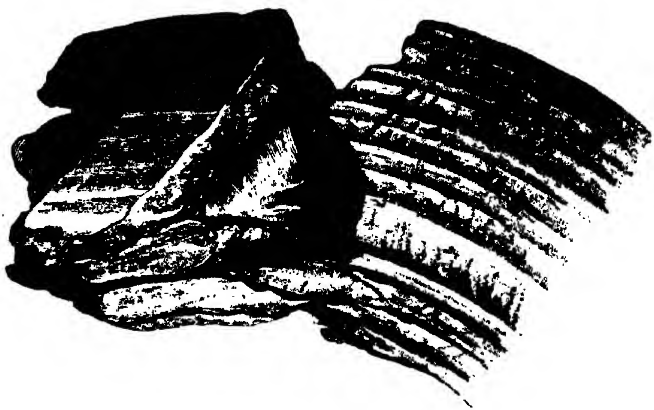
tinct fangs. In either case, the drill, in preparing a hole for the reception of a pivot, may pass through the tooth into the socket.

As a rule, the roots of the incisors and canines only should, other circumstances concurring, be preserved; and preservation even of these will not in all cases be desirable. If, for instance, a lateral incisor be broken off at the age of thirteen, and the root be immediately removed, the canine will come forward, and in a few years fill up the space; or if the accident occurs at a later period in a mouth crowded with teeth, a similar result would follow the operation. A like course may sometimes be pursued in a young patient, when with the lateral incisors large, a small central tooth is injured. Pivoted teeth may last twenty years, or even for a longer time, but such durability must be regarded as exceptional. From seven to ten years would more correctly express the period which will intervene between the insertion of a pivoted and the substitution of an artificial tooth, the use of which must, for the sake of appearance and articulation, be ever afterwards continued. If, then, the space occasioned by the loss of a fractured tooth can be filled up by the gradual approximation of the contiguous teeth without seriously interfering with the personal appearance of the patient, it will be better to remove the root of the injured tooth.

The treatment of roots situated at the back part of the mouth, from which the crowns have been broken, must depend upon the indications presented. If a root is free from pain, and firmly fixed in the socket, but little advantage will be gained by its extraction, unless the neighbouring teeth would come together, and fill up the space.

Hitherto fractures extending through the exposed portion of a tooth, or extending through the crown into the root, have been considered; occasionally the injury is situated within the socket. The tooth, after the accident, remains loose and painful; it is eventually removed, and the precise nature of the injury is revealed. Supposing the tooth had become by degrees less painful, and had regained its firmness, the accident would be forgotten, and the attention might not again be directed to the tooth. The refixing of a loosened tooth would be regarded as a proof that the injury fell short of an actual fracture of any part within the socket. Such a solution of the question would no doubt, in the great majority of cases, be strictly correct, but there is good reason for doubting its invariable accuracy. Mr. Saunders has in his collec-

Fig. 180. (1)



(1) Shows a perfectly united fracture in the tusk of a hippopotamus. The tooth had been broken within the socket, and was attended with considerable separation of the fractured surfaces. The union has been effected by the development of cementum.

tion an incisor which shows the marks of a reunited fracture extending across the root near the junction of its terminal and middle third. A description, with a figure of this tooth, has been published.(1) Professor Owen has described and figured an instance of reunited fracture in the tusk of a hippopotamus.(2) The preparation in my own collection from which the preceding illustration is taken is of great interest, as it at once proves that in the tusk of the hippopotamus, at all events, union may take place after a severely comminuted fracture, with considerable displacement of the fractured parts. In this specimen—and I believe in the two preceding examples—the union is effected by the development of cementum. These facts go to show that when a tooth is fractured within the socket it may, under favourable circumstances, be reunited. To recognise and bring about these circumstances may in individual cases be difficult, but the knowledge that a fracture can be united should lead to a course of treatment favourable to its occurrence in cases where fracture of the root of a tooth is suspected.

In a case which came under my own notice, a front tooth was broken across and a molar tooth loosened by a severe fall in a patient under twenty years of age. The latter tooth was allowed to remain, on the chance of its regaining its original firmness of implantation. After the lapse of many months the molar tooth was still a little loose, and now and then became the seat of pain. The degree of looseness appeared to vary; at one time the tooth seemed to be rapidly recovering its usefulness as an organ of mastication, at another, it

(1) Lecture on Dental Physiology and Surgery.
(2) Odontography.

appeared to be getting from bad to worse. At last the patient determined to submit to no further inconvenience, and the tooth was extracted. The nature of the accident was then for the first time recognised. The root of the tooth had been broken transversely some distance within the socket, and the fractured surface had been subsequently coated over with cementum. The production of new tissue upon the broken surface must be regarded as a reparative effort, and had the tooth been by any mechanical means kept for a time in a state of rest, it is probable that an union of the fractured surfaces would have been effected.

Dislocation of Teeth.—From a blow, a fall, and sometimes from a mistake on the part of an operator or of the patient, one or more teeth are partially or wholly dislodged from their sockets. The alveoli may at the same time receive injury, the severity of which will depend upon the nature of the accident. In injuries received from machinery or from a severe fall, the roots of the front teeth may be driven up into the floor of the nose, or they may be forced out of the mouth with their sockets still attached. For the purposes of practice, the dislocation of teeth may be divided into—partial dislocation, or the mere loosening of teeth; complete dislocation, or the absolute removal of teeth from their sockets; and dislocation accompanied with injury of the alveolar processes.

It is now a well-established fact, not only that a tooth which has been forcibly loosened in its socket will, if allowed to remain at rest, become firmly refixed, but also that teeth which have been removed may, on being returned, after an interval of several hours, become attached, and remain firm and useful for many years. A patient of my own fell upon

a cog-wheel, and knocked out the central incisor of the upper jaw. In the course of half an hour he returned the tooth to its socket, and according to his own statement it gradually became firm, and remained so for upwards of twelve years; at the expiration of that time it became loose and troublesome, and was extracted. When the accident occurred the tooth had the usual length of root, but at the time of its removal the latter part had been reduced to less than half its normal length by absorption. Many similar cases as respects the re-establishment of the natural connexion of completely dislocated teeth with their sockets were brought forward at a meeting of the Odontological Society, held in 1858. On the same occasion, instances of the refixing of teeth, partially dislocated for the purpose of changing their position, were cited by Mr. Woodhouse and Mr. Cattlin, both of whom had practised the operation in the treatment of irregularity in the teeth of young patients. With this ample evidence in favour of the opinion that the membranous connexion of teeth with their sockets may be renewed even after the teeth have been removed from the mouth, there need be no hesitation on the part of the dental surgeon in replacing teeth accidentally dislocated, if the teeth themselves are free from injury, and the alveoli have escaped material damage. Failures in this mode of treatment may arise, and in patients who are out of health, or in whom the gums are in a morbid condition, success would scarcely be expected; but in healthy subjects the preservative treatment will generally be attended with success.

In the management of the case it will be necessary in partial dislocation to urge upon the patient the necessity of

keeping the tooth in a state of perfect rest; and when the attachment is all but destroyed, and the tooth is extremely moveable, it may be necessary also to afford support, by a ligature passed round an adjoining tooth, or by a cap of gutta-percha extending over the dislocated and the contiguous teeth. If the tooth has left its socket, great care must be taken to remove, by washing with warm water, all extraneous matter from its root, and the socket, too, must be perfectly cleared of coagulum before the replacement is attempted. These precautions having been taken, the tooth should be returned to its place, and firmly pressed down to its natural level in the alveolus, and, if necessary, secured by the means previously described.

In cases which come under the third division,—cases in which the accident is accompanied with a considerable amount of injury to the alveolar processes, any attempt at the restoration of the tooth would prove unsuccessful. The teeth, if retained within the mouth by the adhesion of a small portion of the gum or the periosteum, should be removed, together with any detached pieces of bone which may be found in the soft tissues.

Tartar or Salivary Calculus.—The saliva, together with oral and pulmonary mucus, hold in solution various salts, which are precipitated in a greater or less quantity on natural or artificial teeth in those situations where the fluids of the mouth remain at rest. Epithelial scales, and other extraneous matters that may be floating in the oral fluids, or are entangled between the teeth, become impacted in the precipitated salts, and thus contribute to form the concretion usually called *tartar*. And in addition to these, infusorial

animalcules are said to be met with in recent tartar, and their remains in that which has been dried.

Simon says, " Tartar on the human teeth consists of earthy phosphates, epithelium-scales, a little ptyalin, and fat; and when examined under the microscope there are seen abundance of pavement epithelium and mucus-corpuscles: and, in addition to these, numerous long acicular bodies and infusoria of the genera vibrio and monas."

According to Berzelius, tartar is composed of

Earthy phosphates	79.0
Salivary mucus	12.5
Ptyalin	1.0
Animal matter soluble in hydrochloric acid	7.5*

Dr. Wright gives the following as the constituents of healthy saliva :—

Water	988.1
Ptyalin	1.8
Fatty acid	.5
Chlorides of sodium and potassium .	1.4
Albumen with soda	.9
Phosphate of lime	.6
Albuminate of soda	.8
Lactates of potash and soda . . .	.7
Sulphocyanide of potassium . . .	.9
Soda	.5
Mucus with ptyalin	2.6

* Simon's Animal Chemistry, translated by Dr. Day.

Berzelius gives the following as the constituents of nasal mucus, to which the bronchial mucus is very similar :—

Water	933.7
Mucin	53.3
Alcohol-extract and alkaline lactates .	3.0
Chlorides of sodium and potassium .	5.6
Water-extract, with traces of albumen and phosphates	3.5
Soda combined with mucus . . .	3.9

Tartar has been described by dentists as of several different kinds, and named from the variation of colour and density it presents. Thus, one sort is called black, another green, a third yellow tartar. The division is not, however, so far as I know, based upon any chemical difference, and may therefore be disregarded. I conceive that in most instances these physical variations are traceable to the time occupied in its formation, or to the habits of the individual.

Thus when the tartar collects quickly, it is usually soft and yellow; and, on the other hand, when the process is slow, it is dark and hard. Then, again, in those who smoke much, the tartar is of a deep brown or black colour. In teeth where one fang has been necrosed, and stripped of periosteum, the surface of the dead fang is often studded with nodules of very hard greenish tartar, which, during the time of its deposition, has been bathed in pus secreted from the lining membrane of the socket. The tartar is not an active corrosive agent, producing the destruction of the fang, as some dentists have supposed, but its presence is consequent on the death and denudation of the latter.

We commonly find the concretion the most abundant about the lingual surface of the front teeth of the lower jaw, or about the labial surface of the molars of the upper jaw, if from any cause the latter teeth are not used in mastication.

If a vertical section of a piece of tartar be carefully made, it will be found to present a wedge shape, the base of which lies in contact with the gum. The surface towards the tongue or cheek is usually smooth, but that against the gum is rough; and it is to the latter additions are mostly made. The gums become irritated and inflamed from the contact of the rough surface of the tartar; the alveoli become absorbed, and the gum recedes, making way for the further accumulation of the salivary salts. To the dental tissues themselves the tartar does no direct injury, but its effect upon the gums and alveoli is destructive, and hence indirectly upon the teeth, by depriving them of their sockets.

Careful daily brushing will do much to prevent the accumulation of tartar on the teeth, but should an accumulation take place it must be removed from time to time by instruments fitted for the purpose.

Tooth-powder that will dissolve the tartar will also dissolve the teeth, and therefore may not be used.

In young people the permanent teeth soon after their appearance through the gum may become disfigured by the deposition of dark green pigment upon the surface of the enamel near its terminal edge. The seat of the discoloration is, I believe, in the layer of tissue which is continuous with the cementum of the fang of the tooth, and of which a description has already been given. If tartar were present it would project from the general level of the tooth, but in

the cases of green discoloration the surface of the enamel is not raised.

The habitual use of the tooth-brush and the act of mastication gradually rub off the pigment, and the teeth are restored to their proper colour. If, however, the disfigurement remains after the teeth are fully developed and the enamel has acquired density, the unsightly appearance may be removed by rubbing the part with a piece of soft wood loaded with fine pumice powder.

DISEASES OF THE ANTRUM.

The treatment of diseases of the antrum scarcely falls within the province of the dental surgeon, excepting when they result from diseased teeth; and even then the cases would properly come under the management of the surgeon should they assume any other character than that of simple inflammation of the lining membrane of that cavity. The dental surgeon is not called upon to treat fibrous, osseous, or malignant tumours of the antrum, although they may have arisen from or have been aggravated by the presence of diseased teeth, yet it is very desirable that he should be acquainted with the nature of diseases of this class, and the symptoms by which they are distinguished. But when the lining membrane becomes inflamed, and the cavity filled with a morbid secretion, as a consequence of disease set up by a faulty tooth, it will be for the dental surgeon to detect and to remove the offending organ, and to take measures for relieving the malady it has occasioned.

The symptoms which mark the presence of inflammation of the lining membrane of the antrum are a dull aching pain

within the malar bone, accompanied with a sense of distension and weight. The cheek becomes a little swollen and the affection is generally attended with a fulness about the bone below the zygoma. These conditions are usually accompanied by an offensive discharge of mucus from the corresponding nostril. Symptoms of a somewhat similar character may be associated with the earlier stages of malignant disease; it is necessary that the practitioner should be aware of this fact, for should he, under the impression the case is a simple one, remove a carious tooth, he may subsequently have the credit of producing by injudicious treatment a most formidable and probably fatal disease.

As far as my own experience goes—and I speak from very limited experience—the discharge from the nostril which accompanies malignant disease in the earlier state of the complaint is not usually so offensive or so thick and ropy as that which accompanies simple inflammation of the lining membrane of the antrum. There is also another point by which simple inflammation of the lining membrane may be distinguished from the more formidable diseases of that cavity. The teeth are seldom, if ever, disturbed in position by the former malady, but when a morbid growth takes possession of the cavity, the contiguous teeth very frequently become gradually separated from each other, and turned out of their natural direction. Indeed, the disease seldom fails to pass beyond the limits of the antrum, and to encroach upon the neighbouring parts. In a case which terminated fatally, the discharge from the nostril was for some months thin and watery, and destitute of offensive odour.

If, however, the affection be of a simple kind, and conse-

quent upon irritation produced by the roots of a diseased tooth, the offending organ should be at once removed, and the alveolus examined with a probe. If the mischievous tooth has been selected for extraction, the probe will pass through the alveolus into the antrum, and its withdrawal will be followed by a discharge of offensive mucus or pus. Should the opening produced by the removal of the tooth be sufficiently free to allow the collected mucus to escape readily, its enlargement need not be attempted. But if it is found that the aperture produced by the removal of the tooth is barely sufficient to allow of the introduction of a moderate-sized probe, the duration of the disease will be shortened by passing a trocar, or even a small trephine, into the antrum. I believe many cases of diseased antrum are greatly prolonged by the want of a free opening into the cavity through which the morbid secretion can escape. This conclusion is strengthened by the fact recently pointed out by Mr. Cattlin, that the floor is often divided by a transverse septum of bone running across from the labial to the nasal walls of the cavity. With this conformation it is quite possible that the secretion collected in one would remain undisturbed by a current of water thrown through a small opening into the other compartment. After a free opening has been made, the cavity of the antrum should be thoroughly washed out with tepid water thrown in with a syringe, and the operation repeated daily until the character of the secretion of the mucous membrane becomes healthy. In the intervals, a strip of lint must be placed in the opening, otherwise it will rapidly contract, and may become healed up before the disease has disappeared. When the malady has been of long standing, it may be neces-

sary to use a stimulating injection, composed of a weak solution either of sulphate of zinc, nitrate of silver, or chloride of zinc. But should the case prove obstinate, I believe it will generally be found that the opening provided for the escape of the discharge is insufficient to allow of the perfect and daily removal of the accumulated mucus.

PIVOTING TEETH.

The circumstances under which the operation of pivoting may be performed with advantage have been mentioned in connexion with the diseases and the mechanical injuries of the teeth, it will be therefore unnecessary to recapitulate those circumstances before proceeding to describe the operation itself, further than is embodied in the general statement, that the root destined to receive the pivot, together with the surrounding parts, should be perfectly free from disease.

The operation, then, is commenced by removing, by means of the saw, the cutting forceps, or the file, down to the level of the gum, such portions of the crown of the faulty tooth as may still be standing. The choice of instruments will depend upon the condition of the part to be removed. When the neck of the tooth is strong and sound, the saw may be entered upon each side to within a short distance of the pulp, and the operation of excision be completed with the cutting forceps. If the latter instrument only were employed, a risk of shaking the root in its socket, or of splintering it within the gum, would be incurred. If, on the other hand, the neck of the tooth has been encroached upon by caries, or the crown has been broken off near the margin of the gum, the cutting forceps and the file only will be required, or perhaps only the

latter instrument. If, in the preceding manipulation, the pulp has escaped destruction, a fine broach must be passed up the pulp-cavity, and the whole of the pulp withdrawn in the manner described at page 415.

The exposed surface of the root must now be cut down with a half-round file to the level of the gum, and even a little below its free edge. The next step in the operation will consist in reducing the pulp-cavity to a perfectly cylindrical canal, which should be extended to within a short distance of the extremity of the root. To effect this purpose a five-sided broach may be used, but I have found a half-round drill preferable. The latter cuts freely, produces a very true hole, and at the same time follows the course of the pulp-cavity. Several sizes of such instruments will be required, the smaller for commencing, the larger for completing the perforation. From time to time the depth of the hole must be gauged, otherwise the drill may be carried too far. I have seen one or two cases in which the broach has been passed through the root of a tooth into the alveolus.

The root having been prepared, a new tooth must be selected, corresponding both in shape, size, and colour, to the one which has been lost. The choice will lie between a natural and a mineral tooth. If the former be taken, the fang must be removed, and the cut surface of the crown fitted with great accuracy to the exposed surface of the root destined to support it, an operation which can be readily accomplished with a file, the process of fitting being carried on either by using a cast taken of the root and adjoining teeth, or by frequent trials in the mouth. The root having been prepared, and the new crown fitted, the pivot must now

be selected. Two substances are used, wood and gold, and the choice between them will depend upon the condition of the root. If the canal is necessarily large, the wood pivot will be preferable; if it be of moderate size, the gold should be selected. This question having been determined, the pivot must be so placed in the crown, that when passed into the canal of the root the new tooth will stand in the required position. To ensure this result the canal in the crown must be made to correspond accurately with that in the root. In order to ascertain the position the pivot should hold in the crown, a thin layer of softened bee's-wax may be attached to the cut surface of the crown, which should then be pressed into its destined place. By this proceeding the precise spot for the canal will be learned, and the size will be determined by the character of the pivot about to be inserted.

If wood be taken, a piece of hickory, filed or cut into a cylindrical form, and passed through a draw-plate, in order to produce compression of its fibres, and to reduce it to a uniform size, will be found to possess sufficient strength and durability. A cylindrical hole, the size of which should correspond with that through which the wood has been passed, must now be drilled in the crown. Within the hole one or two shallow circular grooves may be cut with a fine excavator. The wood pivot is now pressed firmly into the crown, and reduced to a length corresponding to the depth of the canal in the root. We have now to press the wooden pivot fixed in the crown up the canal in the root of the tooth, until the fitted surfaces of the crown and root come in contact, and the operation is completed. The wood, on imbibing moisture, swells and holds the crown very firmly attached

to the root, so firmly that were their detachment attempted, some care would be required, or the root would leave its socket before the pivot was withdrawn either from the crown or the root of the tooth.

Had a gold pivot been employed, the manner of proceeding would have been varied in the following particulars. A screw must have been cut within the canal in the new crown, and a corresponding thread upon the pivot. The two having been firmly screwed together, the projecting portion of the gold pin should be made slightly rough, and surrounded with a very thin layer of floss silk. In this condition the pin is passed with a firm and steady hand into the canal of the root, to which, by the addition of the silk, the pin becomes accurately adapted.

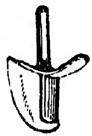
Had a mineral tooth been selected, the process of fitting would have been conducted with the emery wheel instead of the file, and the gold pin attached to the crown by means of soft solder. Teeth of similar composition are also specially made for receiving a wooden pivot, and are fixed in the mouth much in the same manner as a natural tooth.

Although the crown of a tooth can be fixed upon a sound root with sufficient firmness to give to the patient a sense of security, while it answers the purposes of articulation and restores the personal appearance, yet it will not be able to withstand constant collision with an antagonistic tooth. A sound front tooth, when submitted to more than its legitimate share of pressure, is usually forced out of position, and a pivoted tooth would necessarily be still more readily displaced. To avoid this obvious source of injury, the newly-added crown must be so arranged that the opposing tooth,

on closing the mouth, will press upon it but lightly, or fall short of contact. Ordinarily this result may be secured by grinding away the lingual surface, but in certain cases the teeth of the opposite jaw close in a manner that would necessitate the reduction of the new crown to an extent which would render it unserviceable.

Rather than reduce the strength of the crown of the tooth, whether natural or mineral, beyond the proper limits, it will be better to use a flat mineral tooth. The operation will consist in adapting a small gold plate to the surface of the prepared root, in soldering the gold pivot to the plate, and soldering the flat tooth, previously backed with gold, to the outer margin of the plate. When this method of operating is adopted, the tooth may be placed quite out of the way of its antagonist, which, if necessary, may be allowed to close upon the exposed surface of the gold plate which lies over the lingual portion of the root.

Fig. 181. (1)



The operation of pivoting, when undertaken under favourable circumstances, and carefully performed, produces a very satisfactory result. Unfortunately, however, we are not always in a position to form a just appreciation of the attendant circumstances. In the majority of cases the patient suffers no further inconvenience than that which attends the operation, but instances occasionally arise in which inflammation is set up in the alveolus, the gum becomes enlarged, and the face swells. Great pain, at first limited to the alveolus of the pivoted tooth, afterwards diffused over the neighbouring parts,

(1) Shows in profile a flat mineral tooth mounted upon a gold plate, fitted to the root of a tooth, with the pivot destined to pass into the canal of the root, soldered to the gold plate.

attends the progress of the disease, and severe constitutional symptoms are not always wanting. Eventually, suppuration is established within the socket of the pivoted tooth, and the pus when formed finds its way to the surface; but the disease sometimes assumes a more active character, and spreads over a larger surface than an ordinary alveolar abscess. In one case tetanus and death followed the operation of pivoting.(1)

The possibility that unfavourable symptoms may arise, renders it necessary that the patient should be requested to return should the pivoted tooth become painful. If it is found that the alveolar periosteum is becoming inflamed, one or two leeches should be applied to the gum, and the new crown removed, if the pivot can be readily withdrawn. But if the disease has advanced to suppuration, it will be well at once to remove the root before the sockets of the neighbouring teeth become involved. Generally, however, the inflammation, if taken at the onset, may be controlled, and the tooth saved by local bleeding and the administration of an aperient.

Should there be reason to suppose that unfavourable symptoms may arise, it will be advisable to fix the pivot in a manner that will admit of its ready withdrawal, and refix it when all chance of mischief has passed away.

THE OPERATION OF EXTRACTION.

In my previous work, the comparative merits of the key and of the forceps for removing teeth were discussed, and the superiority of the latter over the former instrument, was strongly urged. The very general adoption of the forceps

(1) Loc. cit.

renders it unnecessary that the question of their superiority should be again entered upon.

Subsequent experience has not induced any change in the opinions then expressed in respect to the construction and the manner of using tooth-forceps, neither have I any great additions to make to the instruments formerly described. Under these circumstances, the following description, with the accompanying illustrations, must in the main correspond with the section devoted to the same subject in my Lectures.

In extracting a tooth, the following conditions should be fulfilled:—First, the whole of the offending organ should be removed.

Secondly, Its removal should be effected with as little injury as possible to the structures in which it is implanted.

Thirdly, The patient should be spared all unnecessary pain in the operation.

That method by which a tooth, or the remains of one, can be removed most certainly, quickly, and at the same time with the least amount of injury to the adjoining parts, will also be attended with the least suffering to the patient. To meet these requirements, recourse must be had to an instrument, so formed that it shall grasp the tooth only, and on the application of the required force effect its removal. Such instruments are forceps; forceps so constructed that they will accurately fit the tooth to be extracted, and so fashioned at the jaws, nibs, or blades, that they will readily pass within the gum and separate it from the neck of the tooth.

In the construction of tooth-forceps, certain general principles may be laid down, the observance of which cannot be neglected without prejudicing the general effectiveness of the instruments. The terminal edge of the jaws should fit with

accuracy to the neck of the tooth for the removal of which the instrument is designed. The whole of the circumference of the neck cannot be embraced, but a large portion of its lingual and labial surfaces can be reached by the instrument. The greater the surface over which the pressure is diffused, the less will be the risk of breaking the tooth by the force employed to effect its removal. Assuming the neck to be grasped, the jaws of the instrument should diverge above their terminal edges sufficiently to clear the crown of the tooth, but the divergence must not be greater than is necessary to effect that object, otherwise the form of a cutting instrument will be approached.

In forming the terminal edges of the instrument some little care is necessary. They must be sufficiently thin to pass under the gum and separate it from the neck of the tooth, and, in some cases, even to pass a short distance within the alveolus. At the same time a sufficient amount of metal must be preserved to ensure the requisite strength. If a section were made of a well-constructed pair of forceps for the incisor teeth, each jaw of the instrument would present the outline of a sharp wedge, which, when applied to a tooth, would be in close apposition to the neck of the tooth, leaving the crown untouched. The length of the jaws should be sufficient to clear the crown; any further increase would diminish the power of the instrument, or necessitate an inconvenient length of handle.

Size and curve of handle.—In respect to the length of the handles there is great difference of opinion, and the size of the hand of the operator will not afford any solution of the question. Forceps for extracting the front teeth will necessarily be straight, but those used for the removal of the molars must be more or less curved, and the direction and the degree of

curvature are questions of some importance. The straighter the instrument, the more readily will its action be controlled. On this account it is desirable to limit the curve at the joint, and, in the case of forceps for the upper teeth, to antagonize it by an opposite curvature in the hands. (Fig. 185.)

In instruments for the molars of the lower jaw, the angle will depend upon the direction in which the curve is made. When the jaws are in the same plane as the handles, the angle need not exceed forty-five degrees, but an angle approaching ninety degrees will be required when the plane of the jaws crosses that of the handles. (Fig. 188.)

As the teeth are variously shaped, so will it be necessary to have forceps of different forms; in fact, a pair fitted to each kind of tooth. By forceps constructed on the foregoing principles teeth may be removed in less time than by any other tooth-extracting instrument at present in use; also with less pain to the patient, and without inflicting any further injury on the gums and alveolar processes than must necessarily result from the forcible separation of a tooth from its natural attachments.

In order to secure perfect adaptation, an average tooth may be selected and given to the forceps maker, and he should be instructed to make the jaws fit with accuracy the neck, leaving sufficient room to secure the crown of the tooth from pressure, but not more than will be necessary to clear the enamel.

The fangs of all teeth having a general conical form, forceps, when well made and applied, may be regarded but as a lengthening of the cone in the direction of its base. For removing teeth which are not decayed down to the gums, the ends of the jaws should be square or slightly rounded; but when the root only

of a tooth remains, rounded ends are the more convenient —a shape which facilitates their introduction between the fang and inclosing alveolus. Instruments for extracting stumps should be made altogether lighter than ordinary forceps, and the jaws should be thin and sharp at their edges, so that they may be made to cut rather than to tear the membrane connecting the fang with the adjoining tissues.

When forceps are used for the extraction of teeth, the operation is divided into three stages:—1st. The seizure of the tooth; 2nd. The destruction of its membranous connexion with the socket; 3rd. The removal of the tooth from the socket. It will be of great service to the student, and to those also upon whom he may operate, that strict attention be paid to these stages, and that each should be well and efficiently executed before proceeding to its successor; for should the tooth be unskilfully seized, the crown will be broken off in the attempt to detach it from the periosteum of the socket, without which the fangs cannot be removed from their bony cells. It will be found that a tooth will resist a great force applied in a line with its axis, or, in other words, if an attempt be made to pull a tooth straight from its socket.

In seizing a tooth, the jaws should be closed lightly on the tooth, and inserted under the free edge of the gum, and then *forcibly* driven down to the edges of the alveoli, or even a short distance within them. I say forcibly, because all beginners, and even some practised in the use of forceps, are liable to failure because they do not use sufficient force: they seize the tooth at the edge of the gum, instead of at the edge of the alveolus.

The beginner should be impressed with the necessity of laying hold of the tooth as far down towards the fangs as the instrument can be passed. An old and successful operator, when instructing another in the use of forceps, said—"Push the jaws of your forceps into the sockets as though you intended they should come out at the top of the head, or under the chin."

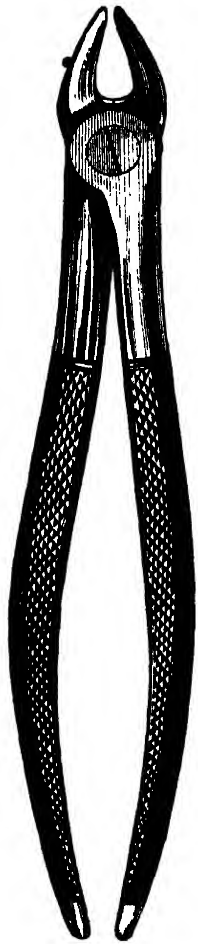
The manner of effecting the second stage will depend on the shape of the tooth to be removed; as will also the third. But different shaped teeth require forceps shaped to them. It will be necessary, therefore, to describe partially the teeth, and then the forceps individually, in order that the peculiar shape of each instrument may be understood. Before doing so, however, I should state that it is quite impossible for any person to extract teeth properly, whatever instrument may be used, especially if the forceps be chosen, unless the operator is perfectly acquainted with the form of each tooth, with the relative position and size of the fangs, with their direction in the alveoli, with the general form of the alveoli themselves, and with the directions in which they offer the greatest and the least resistance.

In describing the manner in which the operation of extraction should be performed on the different teeth, the removal of the incisors, canines, and bicuspid teeth, will be first considered, and afterwards the molars.

A section through the neck of an incisor of the upper jaw will show that the anterior is larger, and forms part of a greater circle, than the posterior surface. Now the end to be attained in the application of forceps, is to apply them over as large a surface as possible, so that the pressure may

be diffused, and the chance of fracturing the tooth by the pressure of the instrument avoided. To extract these teeth, therefore, the jaw to be applied to the posterior, must have a smaller curve than that for the anterior surface. When the forceps are closed upon the tooth, they should embrace not only the anterior and posterior surfaces, but a part of the lateral surface also. A cylindrical tube of thin metal, when pressed upon equally in every direction, will resist enormous force; but if the pressure be confined to one or two points, a comparatively trifling power will crush it: it is so with a tooth.

Fig. 182. (1)



The lateral incisors require forceps made upon the same principles as the central teeth, but somewhat less in size. These are liable to greater variation in external dimensions than any other teeth. Sometimes they are very small indeed; at other times they are almost as large as the central incisors. It will be advantageous, therefore, to have different sizes of instruments from which to select.

The forceps having been well pushed up towards the alveoli, and the tooth firmly grasped, then by a firm and steady turn of

(1) Forceps adapted for the removal of the incisor teeth of the upper jaw.

the wrist, twist the tooth in its socket, and so soon as it is felt to yield to the force, it may be withdrawn with little effort.

Fig. 183. (1)

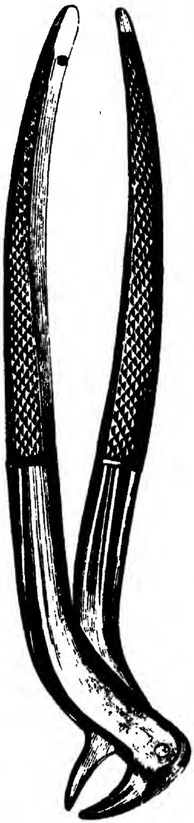
The incisors of the lower are smaller than those of the upper maxilla, and much more compressed laterally. Forceps for the extraction of these teeth will require to have the jaw which is to be applied to the posterior, smaller than that adapted to the anterior surface of the neck. The jaws of the instrument should be straight; but it will be found convenient to have the handles curved, in order to avoid the upper maxilla. When the tooth is grasped it must be forced outwards, the movement being accompanied with the slightest possible degree of rotation, and, when the tooth is felt to yield, it may be drawn upwards and outwards.

The cuspidati of the upper and lower jaws require for each a pair of forceps made upon the same plan as those for the removal of the incisor teeth, except that the instruments must be larger and rather stronger. Those for the cuspidati of the lower maxilla should, like forceps for the incisors of the lower jaw, have the handles slightly bent. Sometimes these teeth are very small, in which case forceps adapted to the adjoining teeth

(1) Forceps adapted for the removal of the lower incisor teeth, with the handle curved to enable the operator to avoid the teeth of the upper jaw.

may serve for their removal. The canine teeth, either of the upper or the lower maxilla, may be detached from their membranous connexion with the jaw by a rotatory movement, and will then leave their sockets readily.

Fig. 184. [1]



The bicuspids will be extracted with instruments similar to those already described, except that there will be a little difference in the jaws, which in this, as in all other cases, must be accurately fitted to the neck of the tooth. These teeth are not very frequently liable to much variety in size, so that an instrument which is well adapted to an ordinary bicuspid tooth will apply itself to almost all. I have forceps in which the jaws are bent at right angles with the handles, and open laterally, for the extraction of bicuspids of the inferior maxilla. But they do not answer so well either as straight instruments, or as those in which the handles are constructed in the manner shown in the adjoining illustration. It is less convenient to apply the necessary force, and more difficult to regulate its direction, in the former than in the latter form of forceps. In extracting a tooth which has its fang laterally

(1) **Forceps suitable for removing the bicuspids of the lower jaw. The joint is placed in an unusual position, and the handles bent in order to allow the hand of the operator to avoid the teeth of the upper jaw. The merit of inventing this useful instrument is due to Mr. Evrard.**

compressed, and placed in an unbroken line with other teeth of like-shaped fangs, the only available movement will be at right angles with the line of the alveoli, and in the direction of the greatest diameter of its root. This motion may be produced whether the forceps employed be straight or curved, as in Fig. 184, or rectangular; but with an instrument of the latter shape the movement must be effected by rotation of the wrist, with a motion upwards. The centre of the rotatory movement will be either at the edge of the jaws of the instrument, or else in a line with the handles of the instrument and wrist. Force applied in this manner would seem to be given at great disadvantage, and an unnecessary amount of it expended on the alveolus; there inflicting injury, which, in the vast majority of cases, may not be complained of by the patient, yet will tend to prevent the mouth from so speedily recovering from the operation as it otherwise would have done.

The bicuspids of the upper jaw have the necks compressed laterally. In removing them, whatever be the form of the instrument used, the force must be first applied in a direction outwards and at an angle to the dental arch. The tooth should be moved outwards and inwards, and then drawn downwards. But it must be borne in mind that in forcing it outwards or inwards we desire only to break its connexions with the socket, and not to draw it out; and that if the force be continued in the angular direction with the hope of removing the tooth, that it will probably be broken off.

The bicuspids of the lower jaw have more conical fangs than those of the upper, and hence may be detached by rotation, and then lifted out of the socket.

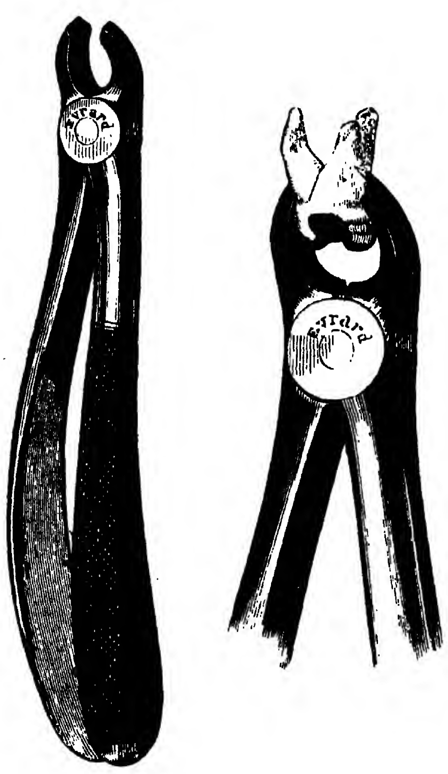
When I say rotation, I do not mean that the tooth shall be twisted a half or even a quarter turn, but that it shall be

twisted till its attachments are felt to give way. If in order to effect this, more force is required than can be judiciously employed, then the direction may be changed, or the rotatory movement abandoned. There are some teeth that vary so much from the usual form of root that they cannot be turned in the socket. The degree of force that it is necessary to employ, in this and in all other cases of like operations, can be learned only in practice.

On extraction of the molars.—The molars of the superior maxilla have three fangs—two external, one internal. Of the two external fangs the anterior is the largest, and is placed in a plane slightly external to the posterior fang, which is both shorter and smaller. The third, the internal fang, is thicker and of greater length than either of the others, and is situated opposite to the posterior external, and to the space between that and the anterior external fang. The divergence of the fangs takes place at the point where the tooth becomes concealed in the alveolus, leaving the neck with a form such as would result from the agglutination of the fangs having the described relative position. At this point the forceps should be applied for the removal of the tooth. Instruments—for it will require two, one for each side, right and left—must be made upon the same general principles as those already described. The jaw for the labial surface of the tooth must have two grooves—the anterior the larger, the posterior the smaller, and upon a plane internal to the anterior groove. The jaw for the lingual surface must have but one groove, and that should be fitted to the base of the internal fang. From the position of the molars of the superior maxilla, the jaws of the instrument for their extraction must necessarily be bent at an angle with the handles.

This angle should not be more than is absolutely necessary, for the more curved the instrument, the greater is the difficulty of using it. The handles should have a general curve in the opposite direction to the jaws. (Fig. 185.)

Figs. 185 and 186. (1)



The molars of the superior maxilla have the two external fangs parallel to each other in their direction in the alveoli. The internal, which is not only the largest but the longest also, diverges from the labial fangs, and passes upwards and inwards towards the internal wall of the antrum, and is embraced by tolerably dense bone. The external alveoli are composed of thin and porous bone.

In removing an upper molar, the tooth, being firmly grasped at its neck, the first motion should be slightly inwards, to disengage the fangs

(1) Forceps for removing the superior molar on the right side of the mouth. In the second figure the instrument is shown embracing a tooth.

from the external alveoli. The force should then be directed downwards and outwards in a line with the course of the internal fang. If these precautions be observed, no difficulty will be found in removing the superior molars. The first and second molars of the superior maxilla are so nearly alike in size and shape, that an instrument well fitted to one will serve equally well for the removal of the other.

The first molar, however, if isolated by the previous removal of the second molar and the second bicuspid, will, when their vacated alveoli have been filled with solid bone, offer great resistance to extraction, and is sometimes broken off in the attempt. Indeed, a solitary tooth surrounded by firm bone is always more difficult to extract, and requires more care, than one situated in a continuous row of teeth.

In the third molars, or dentes sapientiæ, of the upper jaw, though the fangs are often united into one conical mass, yet the shape of the neck of the tooth is so like those of the preceding teeth, that an instrument which is suited for the removal of the anterior molars is often sufficiently well adapted for the removal of the wisdom teeth. The dentes sapientiæ are, however, sometimes much smaller than the other molars; in which case a smaller instrument might be required, but that, when of small sizo, the wisdom teeth are for the most part removed by the application of so slight a force that any instrument by which they can be embraced will serve for their removal.

The molars of the lower jaw have two roots, a distal and a mesial root, which at their union form the neck of the tooth, and leave upon it a depression or groove on the lingual and labial surfaces. A transverse section through the neck of a lower molar, in outline resembles a rude figure

of 8, and it is to the surface so formed, that the jaws of the forceps must be adapted.

The two roots are not equal in size, neither are they strictly parallel in position. The mesial or anterior is both broader and thicker than the posterior or distal root. Their position as regards each other is slightly oblique, giving at the point of confluence at the neck of the tooth a slightly greater breadth to the labial than the lingual surface. The position of the tooth in the jaw is also a little oblique. A line passed from the centre of the labial across to the centre of the lingual surface of the neck would, if continued, proceed over the tongue, with a slightly diagonal direction backwards. Owing to these peculiarities in the form of a lower molar tooth, it becomes desirable to possess forceps destined to effect their removal fitted to the teeth on each side of the mouth—an instrument for the right, and one for the left teeth. One pair may be made to answer the purpose, perhaps, but the obliquities of position and conformation render it quite impossible to adapt the jaws of one instrument to fit with accuracy to the necks of both right and left lower molar teeth. The handles must necessarily be placed at an angle with the jaws of the instrument, and the angle will be determined by the plane in which the jaws are bent. If in the same plane as shown in Fig. 187, an angle of 138 degrees will be sufficient, but should the jaws lie in a plane transverse to the direction of the handles, Fig. 188, an angle of 45 or thereabouts must be produced. These instruments may in some instances be found suitable for the removal of the third molars —the dentes sapientiæ of the lower jaw. Generally, however, these teeth are situated so far back in the mouth, and are separated from the corresponding members of the

Fig. 187. (1)

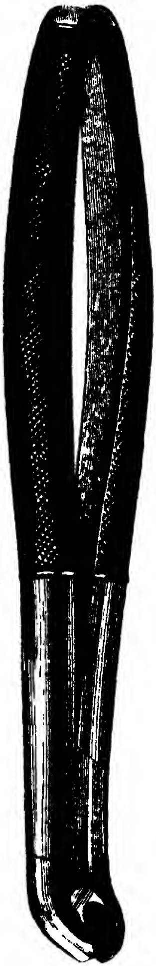


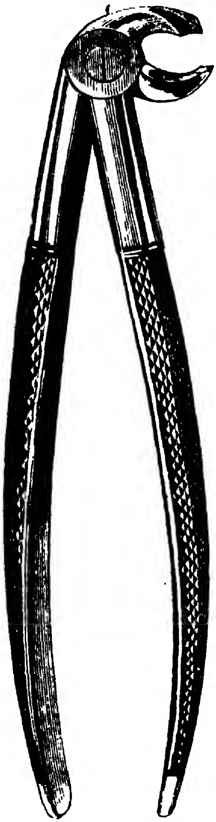
Fig. 188. (2)

(1) Fig. 187. Forceps for the removal of molar teeth of the lower jaw. The jaws are fitted to the necks of the teeth, bent at an angle of 45, and in a plane parallel with that described by the handles.

(2) Fig. 188. Forceps, the jaws of which are placed at a right angle, and in a plane transverse to that of the handles.

upper series when the mouth is opened to its fullest extent by so small an interval, that although a modified instrument may not in all cases be absolutely necessary, it is at all events more convenient. An instrument, the jaws of which, in addition to standing at a right angle with the handle in the transverse plane, are also themselves curved forward (Fig. 189), I have found particularly serviceable, not only in extracting the third, but also the second molar teeth. A right and left pair will of course be required.

Fig. 189. (1)



The old adage, that the best workmen are known by the fewness of their tools, if true in former years, falls far short of the truth in modern times. The best work is produced by those who have at their disposal the most perfect mechanical appliances, and it is so in the practice of general and special surgery. Those who have the best-made and the most perfectly adapted instruments, will, other circumstances being equal, operate with the greatest success.

A deviation from the normal form

(1) Forceps for the removal of second or third lower molars, situated in the right side of the mouth.

The jaws of the instrument are placed at a right angle, and in a plane transverse to that of the handles. The jaws themselves are curved in a manner which allows the instrument to be passed to the back part of the mouth.

is exceptional in any member of the dental series, excepting in the dentes sapientiæ. In these teeth the converse holds good, the typical form is more frequently lost than retained, and it is on this account that the operator should be prepared with suitable means for meeting such exigencies as may arise. The question of irregularities of form will, however, be subsequently referred to.

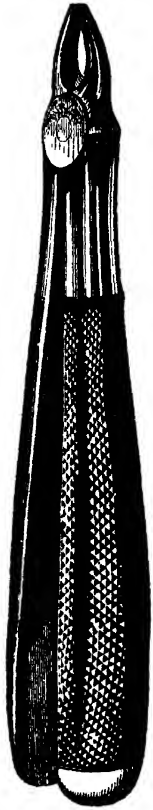
In removing molars of the lower jaw, the blades of the instrument, whatever may be its form, should be carefully thrust down to the free edge of the alveoli, which part of the operation is easily effected, in consequence of the decreasing size of the teeth from the crown to the fangs. Having obtained firm hold of the neck of the tooth, the first motion should be inwards, by which the tooth is detached from the external plate of the alveoli: afterwards the tooth should be drawn outwards and upwards, and so removed. The fangs of these teeth, however, not unfrequently take a curve backwards; if therefore a lower molar offers considerable resistance when its extraction is attempted, the movement after the tooth has been forced laterally, should not be in a straight line, but in a curved direction, corresponding to the course taken by the roots.

When an instrument having blades curved in a plane with the handles is used, the operator must stand in front of the patient, and the power will be exercised by rotation of the wrist; but if the instrument with the jaws bent at a right angle and in the transverse plane be selected, the dentist in removing the tooth from the right side of the mouth will stand behind, and in operating upon the left side of the jaw in front of the patient. The handles of the instrument will project

from the side of the mouth, and the power employed in the removal of the tooth will be exercised by raising and depressing the hand. It is to these rectangular instruments that I generally give the preference.

In the foregoing description it has been assumed that a considerable portion of the crown remained, and that the

Fig. 190. (1)



(1) Forceps for removing the roots of single-fanged teeth situated in the front part of the upper jaw.

condemned tooth, therefore, could be readily grasped at its neck. It often happens, however, that the tooth has decayed away, or been broken off to a level with, or below the edge of the gum; in either case the instruments at present described are inapplicable. Stump-forceps, or the elevator, must be employed to effect the removal of such teeth.

There are two forms of stumps, single and double, or triple. Single-fanged teeth necessarily leave only a single stump, but in molar teeth a sufficient portion of the neck may remain to preserve the connexion of the roots. For the extraction of single stumps we require one kind of instrument, for double another, and for triple-fanged stumps a third.

In forceps for removing single stumps the jaws should be grooved to fit the stump, made very sharp at the edge, and of well-tempered cast steel, so that the edge may be renewed from time to time on the oil-stone. When the instrument is closed, they hold the stump, and fit to its whole length.

In the construction of these instruments, care should be taken to allow a sufficient interval between the upper part of the blades, otherwise they will close upon and crush the exposed and fragile portion of the stump, before the terminal portion of the blades bears upon the part capable of resisting the required pressure.

Although little variety will be required either in the size or in the form of the jaws, the relations they hold to the handles will require variation, in order to admit of their application to stumps situated in different parts of the mouth. Of these varieties the succeeding illustrations will afford examples.

The edge of the blades having been rendered moderately sharp, they should be closed lightly upon the stump, and then forced between it and the edge of the alveolus. In many cases

simple pressure will carry the instrument to a sufficient depth, but in others a slight amount of rotation will be found neces-

Fig. 191. (1)

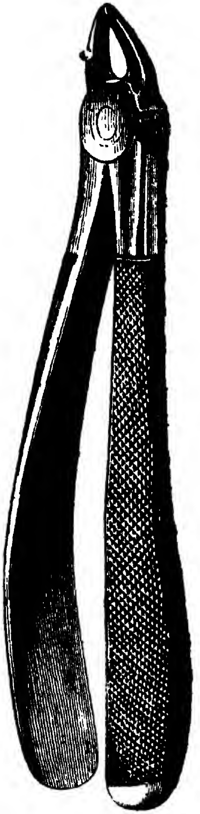
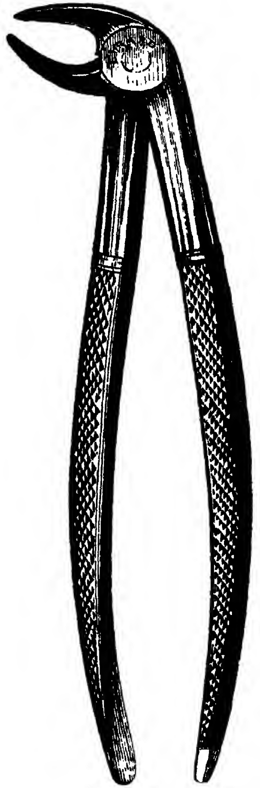


Fig. 192. (2)



(1) Forceps for removing the detached roots of the upper molar or bicuspid teeth. The jaws of the instrument are slightly curved upwards, and the handles in an opposite direction, in order to enable the operator to reach the back part of the mouth.

(2) Forceps with the jaws bent in a plane transverse to the direction of the handles, for the removal of the roots of the lower bicuspid teeth. For the extraction of stump of the lower molar teeth, a considerable advantage will be gained by a slight curve in the blades below the joint, as shown in fig. 189.

sary. The root, when embraced at a point capable of resisting pressure, is readily removed. The direction in which the force

Fig. 193. (1)

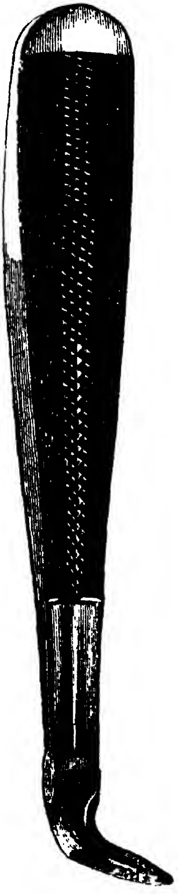
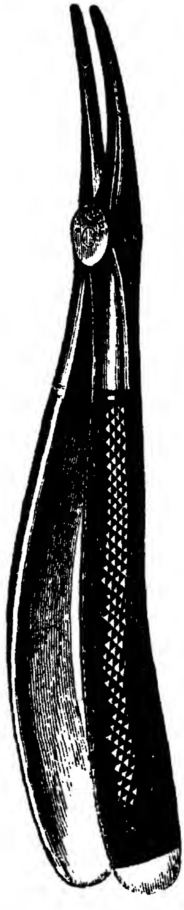


Fig. 194. (2)

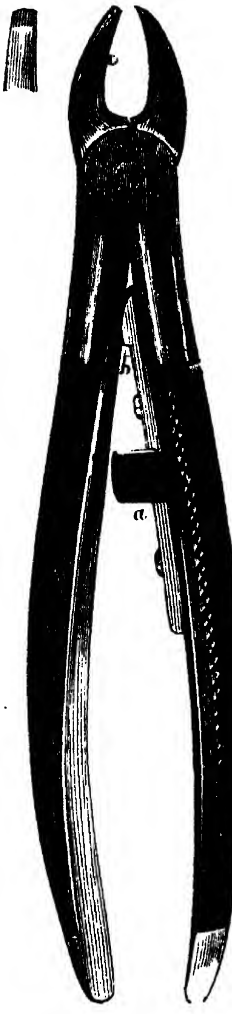


(1) Forceps with blades bent at an angle in the same plane as the angles for the removal of the stumps in the lower jaw.

(2) Forceps with long slender blades for picking out of the alveoli the loose roots of teeth, the crowns of which have previously been removed.

should be employed in effecting its extraction will be regulated by the shape of the root under operation—a point already discussed in a previous page. Occasionally the margin of the alveolus is so unusually strong that it becomes extremely difficult to introduce ordinary stump-forceps, and the difficulty in operating is still further increased when the stump requiring removal has been broken off on a level or a little below the terminal edge of the socket. To meet the difficulty, Mr. Cattlin has devised an instrument, shown in the accompanying illustration. If instead

Fig. 195. (1)



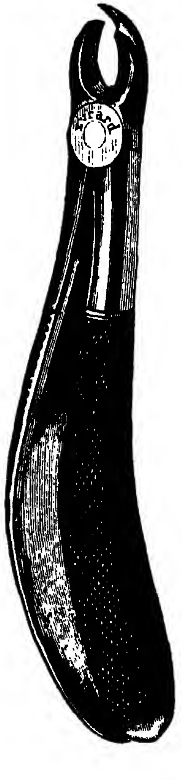
(1) Forceps, the edges of the blades of which are cut into teeth like a saw, for the purpose of operating upon roots presenting a conical surface. The instrument is provided with a stop between the handles. The thumb-piece (*a*) is pressed upon and forces the wedge (*b*) forward, and prevents the blades from closing, the sharp edges of which, by rotation, are made to cut their way into the stump, or between the stump and alveolus. When a sufficient depth has been reached to enable the blades of the instrument to take a firm hold, the wedge is withdrawn by the thumb, and the instrument used as an ordinary pair of stump-forceps. I am indebted to Mr. Cattlin, the inventor of the instrument, for this illustration.

* Shows the grooved surface of the wedge, which rests against a similarly grooved surface on the handle of the instrument.

of simple or single we find compound roots—the roots of molar teeth united by the presence of a portion of the neck of the tooth—an advantage will be gained by adopting a different form of instrument to any at present described. For remov-

Fig. 196. (1)

Fig. 197 (1)



(1) Forceps for removing upper molar teeth, the crowns of which have been broken off, while the connexion between the three roots has been preserved. The peculiarity of the instrument consists in the production of a tapered prolongation of the outer jaw, capable of passing between the labial roots of the tooth. In the first figure the jaws are shown embracing a crownless tooth, in the second the instrument only is shown.

ing the compound roots of an upper molar, an instrument will be required similar, as respects its general form, to that which would be used for the extraction of the tooth, but with the outer or labial blade prolonged into a point.

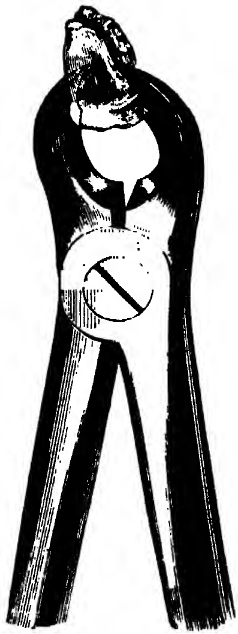
The palatine blade has, at the suggestion of Mr. Coleman, undergone a slight modification. The terminal portion is somewhat reduced in thickness, and turned a little outwards in a direction corresponding to the course taken by the root of the tooth as it enters the alveolus. Instruments constructed on this principle were shown to me many years since by Mr. Rogers, and to him I am indebted for patterns from which many have since been made.

In operating, the palatal blade must be pressed into the alveolus of the corresponding root, and the point of the labial blade placed over the interval which separates the two labial roots. This position having been gained, the point must be driven through the gum and alveolus into the space which separates the labial roots by closing the handles of the instrument. By this procedure a firm hold upon the triple root is obtained, and its removal is readily effected, unless the connecting portion of the tooth gives way. In that event the roots become separated from each other, loosened in their socket, and are very readily removed by a more simple form of stump-forceps. Before applying the instrument it is desirable to make an inverted V-shaped incision over the labial roots of the tooth, to receive the point of the labial blade of the forceps. If this precaution be neglected, the gum may be torn, and the patient will be submitted to unnecessary pain.

It is in the extraction of connected roots of the first molar teeth that forceps constructed upon the foregoing principle

are more especially useful. In the upper wisdom teeth the position and the number of the roots cannot be ascertained. They are frequently connate, and may be treated as simple roots. Even the second molars sometimes depart from the usual form; if, therefore, any difficulty is experienced in introducing the labial blade of the forceps, its use had better be abandoned in favour of a more simple instrument.

Fig. 198. [1]



The double root which remains after the crown of a first or second molar of the lower jaw has been reduced to the level of the gum, may be removed by an instrument constructed upon similar principles to that which is used in extracting the triple fangs of the corresponding upper teeth, differing, however, in having each blade terminated by a point. The points are destined to pass between the roots of the stumps, and when a sufficient portion of the neck of the tooth remains to act as a guide, they may be forced into that position without passing through the labial and lingual plates of the alveolus. The occasional irregularity in the disposition of the roots, more especially

[1] Forceps for removing lower molar teeth, the crowns of which have been broken off through the lower portion of the neck, leaving the two roots firmly connected. The blades are lengthened into points, which converge and pass between the roots of the tooth.

of the second molar, must in this, as in all operations upon the teeth, be borne in mind.

The most generally useful instrument for extracting the roots of teeth has yet to be mentioned. There is scarcely a root, or even a tooth, which cannot be removed by the elevator. The instrument consists of a blade terminated something like a spear-head, and a stout shaft mounted in a strong handle. The minor modifications to which this instrument has been subjected, in order to meet the exigencies of a particular case or the views of the operator, are endless. The accompanying illustrations show two of the more useful forms of the instrument, the one a straight, the other a curved elevator. Independent of the form, the following conditions should be observed in constructing the instrument. The blade and shaft must be made of good steel, and re-

Fig. 199. (1)

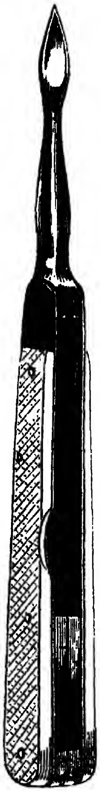
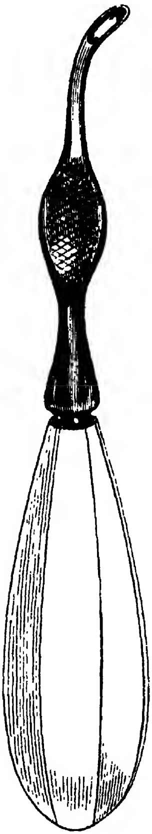


Fig. 200. (2)



(1) Shows an elevator of the most simple description, with the blade hinged to shut into the handle.

(2) A curved elevator, proposed by Mr. Thompson.

duced to a spring temper. The handle should be full and strong, and the whole instrument sufficiently stout to bear without bending or springing any force the operator may employ.

In operating, an elevator may be employed as a simple lever. The edge of the blade having been made sharp, it is thrust down between the root of the tooth and its alveolus; the handle is then depressed with a slight rotatory movement, and if the motion be judiciously directed, the round part or back of the blade will rest upon the margin of the socket, while the edge of the blade cuts into and takes a hold in the surface of the root. The instrument becomes a lever of the most simple kind, the short end of which takes its bearing on the tooth; the alveolar processes, or perhaps the neck of a contiguous tooth, forms the fulcrum, and the long end of the lever is in the hand of the operator. By the depression of the handle the tooth is raised in its socket; but simple depression will not in all cases be sufficient to secure the full effect. A slight degree of rotation is generally necessary, otherwise the edge of the instrument, instead of entering, may slip over the surface of the tooth. Many teeth, more especially the wisdom teeth, may be forced or prized out of their sockets by a single effort, but the second or even the third application of the instrument may be required. A tooth may be so placed with respect to the jaw or the neighbouring teeth, that after it has been moved in its socket, a change in the direction of the force becomes necessary in order to complete the operation without inflicting needless injury on the adjoining parts.

An elevator may, however, be used otherwise than as a

lever. A root, the implantation of which is not very firm, may be forced out by pressing the point of the instrument against it, the direction of the force being such as will favour its escape from the socket. If, for example, the root of a bicuspid on the right side of the upper jaw requires removal, the operation may be performed in the following manner:—Let the patient's head be well thrown back, and placed immediately in front of the operator. The upper lip may be raised by the fore-finger of the left hand. The point of the elevator should be passed upwards between the gum and the tooth until a sound portion of the root is reached. At this point the extremity of the instrument should be pressed into the root sufficiently to take a firm bearing, and the handle of the elevator at the same time brought up to the side of the cheek. When this position is gained the offending root may be pushed out of its socket.

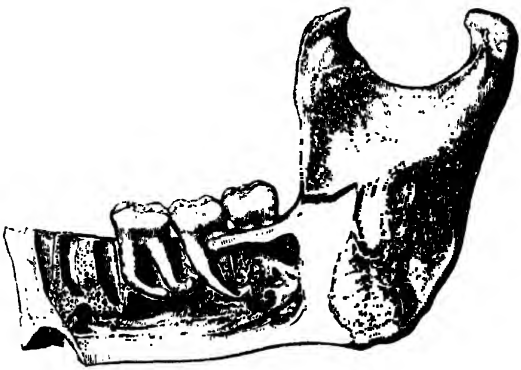
Although the instrument under consideration admits of being used upon either of the foregoing principles, it would be found very inconvenient in the treatment of a case to insist upon the adoption of one method to the exclusion of the other. Not uncommonly the operation may with advantage be commenced by using the elevator as a simple lever, and completed by using it for pushing the loosened tooth out of its socket.

In treating of the extraction of teeth, it has hitherto been assumed that the operator will encounter no unusual obstacle, and the difficulties which sometimes arise in the progress of the operation have been reserved for separate consideration.

The practitioner, it is presumed, will be well acquainted with the normal form of each member of the dental series, but

the normal character of the crown does not necessitate a similar condition of the root of a tooth, and an irregularity in the latter will be discovered only when the operation of extraction is attempted. It is not unusual for the roots of the inferior molars to be curved backwards; and now and then the curve is produced into a positive hook. (Fig. 201.)

Fig. 201. (1)



Had the extraction of either the first or second molar, shown in the accompanying illustration, been attempted, either the ends of the roots would have been left in the jaw, or a large piece of the alveolus brought away with the tooth. The former accident would probably have occurred; the tooth, to use a patient's words, would have been broken in the jaw.

The question as to what shall be done with the roots of such a tooth when broken in the jaw, is at once raised. In my own practice I invariably allow the extremity or even the lower third of a root to remain, provided it is not loose or

(1) A lower jaw, the external portion of which has been removed, so as to show the position of the roots of the molar teeth, which in this example are curved backwards, with the points turned upwards.

the subject of disease. If it be loose its removal is readily effected, and should it have been connected with an alveolar abscess, its removal will not be attended with difficulty. The digging out—if the expression be allowed—of the terminal third of a sound and firmly attached root is productive of great pain and a considerable amount of injury to the alveolus; but the presence of the root, if undisturbed, is very rarely indeed followed by any inconvenience.

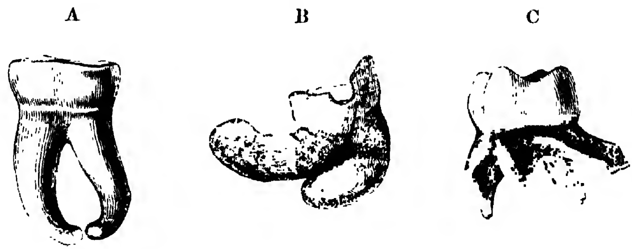
In the example figured (Fig. 201), the roots of the teeth, though curved, are comparatively small, and might probably give way under a force which would not strike the operator as being greater than that required to effect the dislocation of firmly implanted teeth. But it occasionally happens, from some unseen cause, that a tooth for a time remains unmoved, although a force more than sufficient to remove an ordinary tooth has been employed.

It is when placed under this difficulty that the knowledge and skill of the operator are put to the test. The roots of the tooth may be curved, or they may be unusual in size or number, and the tact to recognise the direction in which the resistance lies, and the knowledge of the irregularities of form to which the several roots of the teeth are liable, becomes highly valuable.

In the following illustration three forms of irregularity are shown; the tooth with the convergent, and that with the four divergent roots, would be removed by force employed in the usual direction. In the one case the operation would result in the fracture of one or both roots, or the withdrawal of the portion of the alveolus enclosed by their convergence; in the other, in the fracture of one or more roots, or

perhaps in the removal of a portion of the labial or lingual wall of the alveolus. But if a similar course were pursued

Fig. 202. (1)



with the wisdom tooth, it would break off at the neck, or the tooth would effectually resist the efforts of the operator. With the forceps, it would be very difficult to extract such a tooth, but by adopting the elevator, the tooth could be gradually prized out of its socket without difficulty.

In operating upon teeth in the upper jaw, similar difficulties may arise. An unusual size of the one, or the occurrence of several roots even in a bicuspid tooth, will sometimes embarrass the operator, by raising a doubt as to whether the tooth will give way under the force he is employing. Similar difficulties, consequent upon similar causes, will arise with respect to the molar teeth of the upper jaw. The application of the usual force may not be attended with the usual result.

Fig. 203. (2)

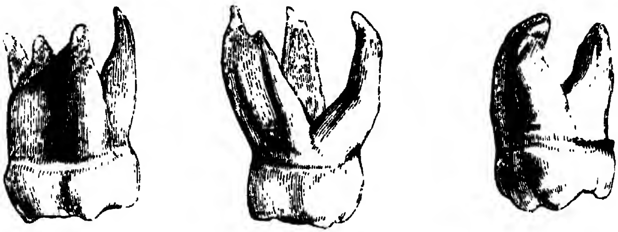
(1) A shows a first permanent molar of the lower jaw, with the roots convergent, and C a corresponding tooth with four divergent roots.

B, a wisdom tooth, with the roots curved backwards, and thickened by hypertrophy of the cementum.

(2) Shows a first bicuspid of the upper jaw, with three distinct roots.

The remedy will consist in steadily increasing the force and varying its direction, feeling our way as it were until the tooth is separated from its socket.

Fig. 204. (1)



The wisdom teeth of the upper jaw, though frequently the subjects of irregularity, being implanted in comparatively porous bone, very seldom resist the efforts of the operator.

The irregularities of form to which the teeth are liable having been described in a preceding part of the volume, need not be again particularized.

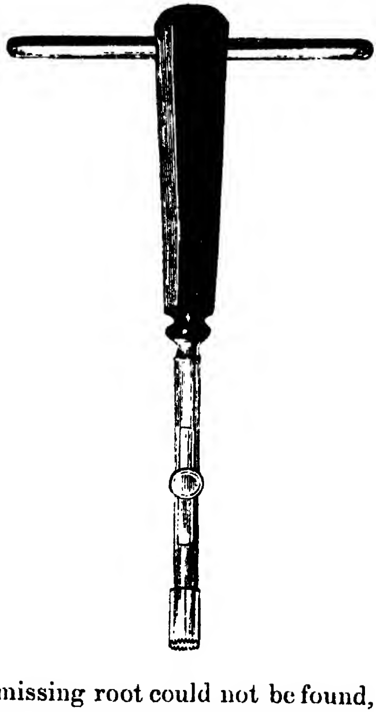
Owing to an unusual thickness and strength in the alveolus, the removal of a tooth is sometimes attended with unusual difficulty, and the operator is still further embarrassed when the crown of the tooth so circumstanced is broken off on a level with the alveolar margin. Generally the stump-forceps or the elevator may be made to enter the alveolus, but exceptional cases may arise. To meet these, Mr. Cattlin proposes to cut away with a small trephine a portion of the outer plate of the alveolus. (Fig. 205.) The root when thus exposed is readily dislodged by an elevator.

Among the accidents which will sometimes occur, even in

(1) Shows first permanent molar teeth of the upper jaw, the roots of which are irregular in size, number, or position.

the practice of the most careful and skilful operators, the following is deserving of notice. The root of an upper molar tooth sometimes passes through the floor of the antrum, and may possibly become enlarged within that cavity. When an attempt is made to remove the tooth the root may be broken. Such an event occurred in the practice of Mr. Cattlin. The root of a molar tooth was left in the jaw, and on its dislodgment being attempted, it passed into the cavity of the antrum. The patient's father died from malignant disease, it was consequently deemed prudent, not only by Mr. Cattlin, but by Mr. Stanley and other surgeons of eminence, to remove the stump, fearing that it might become a source of local irritation. A trephine was applied to the labial plate of the alveolus, and the cavity of the antrum laid open. For some time the missing root could not be found, and it was only by employing a cup formed of gutta-percha

Fig. 205. (1)

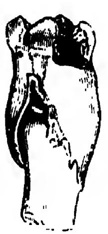


(1) A small trephine, for cutting away the edge of the alveolus, in order to facilitate the removal of the deeply imbedded roots of molar teeth. The figure is taken from an instrument placed at my disposal by Mr. Cattlin.

mounted upon a piece of bent wire, that its presence was detected. The floor of the antrum was divided into two compartments by a septum of bone, and the root had become lodged in the posterior of these. A strong current of water was used without effect, but with the gutta-percha cup its removal was readily accomplished. The case was embodied in a paper upon the Antrum, read before the Odontological Society in the session of 1858. (1)

It has not been deemed necessary to enter specially upon the extraction of temporary teeth, but a complication sometimes arises to which attention may with advantage be directed. It has happened on two occasions which have come to my knowledge, that in extracting a second temporary molar of the lower jaw, the permanent successor has come away, embraced by the roots of the temporary tooth. In each instance the gum has been inflamed as a result of disease set up in the pulp of the temporary tooth, and it is probable that the alveolar processes had in each case also been greatly reduced, if not altogether removed, by absorption. It is well to bear in mind that such an untoward accident may happen when the gum and alveolar periosteum have been for some time inflamed, but I do not know that any precautionary measures can be adopted.

Fig. 206. (2)



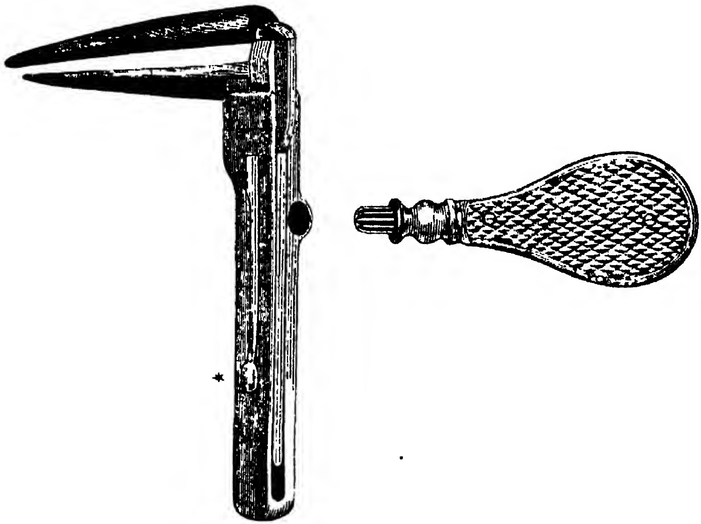
Before the operations upon the teeth are dismissed, a very

(1) In this paper the reader will find an account of the modification of form to which the antrum is subject.

(2) Shows a second temporary molar tooth, in the extraction of which, during the presence of alveolar disease, the developing second bicuspid was withdrawn firmly embraced by the converging root of the temporary tooth.

useful form of speculum for opening the mouth when from any cause the lower jaw becomes fixed, may be brought before the attention of the reader. It consists of two flattened blades, which close together like a bird's bill, the lower passing into a concavity within the upper blade. Upon the steel,

Fig. 207. (1)



which gives strength to each blade, a covering of horn is riveted, and a small piece of gutta percha is let into the surface against which the teeth are destined to rest. From the jaws

(1) An instrument devised by Mr. Cattlin for opening the mouth, when from any cause the jaws become rigidly closed. It consists of two sliding bars, or stems, moved by a rack and pinion, and held in position by a spring catch, shown at *. The blades, or jaws, are continued in steel from the two portions of the stem, and are covered with horn. The handle or pinion, is shown detached from the body of the instrument.

or blades of the instrument, two steel rectangular stems are continued, the one passing within the other and rendered moveable, the one within the other, by a rack and pinion motion. The separation of the blades is effected by a removeable handle, and they are allowed to again approach each other by releasing the spring catch. The construction of the instrument will be readily seen on referring to the figure.

ANÆSTHESIA.

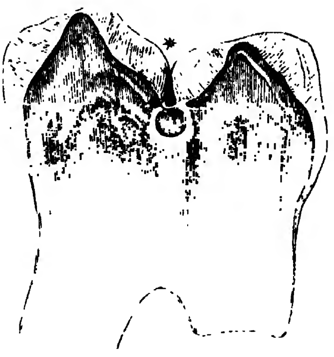
The subject of general anæsthesia as induced by the inhalation of the vapour of chloroform or ether, need not be specially discussed in connexion with dental operations. The agents capable of producing anæsthetic effects have taken their place among the many substances used by the surgeon; and in the works devoted to materia medica and therapeutics their respective merits are fully discussed.

The passage of an electric current through a tooth about to be extracted, has recently been proposed as a means of producing local anæsthesia. Many practitioners have been engaged in experiments with the view of determining the value of the new agent, but the results hitherto recorded have not been sufficiently uniform to warrant the conclusion that the electric current will be found generally available for producing local anæsthesia in dental operations. The electric current may, like the process of congelation, prove serviceable in exceptional cases only; and should it be found that the advantages which may result from the use of the one or the other must, in each instance, be determined by experiment,

the great inconvenience attending the application of a freezing mixture, and the increased pain which is frequently produced by the electric current, will, after the excitement produced by novelty, induce the dental surgeon to abandon their use.

The following figure was accidentally omitted at page 313.

Fig. 208. (1)



(1) Shows a transparent zone of dentine, removed a short distance from and surrounding that which is undergoing decomposition consequent upon caries.

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THE END.